VOLUME LVIII SEPTEMBER, 1948 NUMBER 9

THE LARYNGOSCOPE

FOUNDED IN 1896
BY
MAX A. GOLDSTEIN M.D.

PUBLISHED BY
THE LARYNGOSCOPE
640 SOUTH KINGSHIGHWAY ST. LOUIS (10), MO., U. S. A

NOTICE TO CONTRIBUTORS

THE LARYNGOSCOPE reserves the right of exclusive publication of all articles submitted. This does not preclude their publication in Transactions of the various Societies.

Manuscripts should be typewritten, double spaced, on one side of paper only and with sufficient margins to allow for corrections.

References should be complete: author's surname, initials, title of article, journal, volume, page, month, year.

Six illustrations will be furnished for each article without cost to author. Authors will please limit illustrations to six or assume the expense of additional illustrations.

Proofs will be submitted to authors for corrections. If these are not returned, articles will be published as corrected in this office.

Reprints will be furnished at the following prices:

WITHOUT COVER

	250 Copies	500 Copies	1000 Copies	2000 Copies
Four Pages	$10.25	$12.00	$15.50	$24.00
Eight Pages	20.75	25.75	33.00	52.25
Twelve Pages	31.00	40.00	57.00	89.00
Sixteen Pages	40.50	49.00	65.50	98.00
Twenty Pages	48.00	58.75	79.50	121.00
Twenty-four Pages	58.00	70.50	95.00	143.50
Thirty-two Pages	76.75	91.25	121.25	179.00

WITH COVER

Four Pages	$19.00	$23.75	$33.25	$53.25
Eight Pages	29.50	37.50	52.75	81.50
Twelve Pages	39.75	51.75	74.75	118.25
Sixteen Pages	49.25	60.75	83.25	127.25
Twenty Pages	56.75	70.50	97.25	150.25
Twenty-four Pages	66.75	82.25	112.75	172.75
Thirty-two Pages	85.50	103.00	139.00	208.25

Express charges to be paid by consignee.

THE
LARYNGOSCOPE.

VOL. LVIII SEPTEMBER, 1948. No. 9

RHINOLOGY IN CHILDREN, RESUME OF AND COMMENTS ON THE LITERATURE FOR 1947.

D. E. S. WISHART, M.D.,
Toronto, Canada.

In this resumé of the literature pertaining to rhinology in children for 1947, the same journals have been covered as in previous reviews, but because of the widespread interest in the antibiotics, several other journals devoted to allergy and to diseases of children have also been included. The same order of discussion has been followed as in previous years.

GENERAL ARTICLES ON RHINOLOGY AND ACCESSORY SINUS DISEASE.

The taking of the history of a child, whose nose is being complained about, requires thoroughness, patience and knowledge of the conditions which may or may not be found on subsequent examination. But of greater importance in this history taking—usually with the child present—is the understanding of the parent which the surgeon should gain, an understanding which can be of inestimable value to him when he later gives his advice regarding treatment and his prognosis. The importance of this is emphasized in the following abstract. There are times when the fault is in the mother and not in the nose of the child.

Alvarez[1] considers that practically every physician should know much about psychosomatic medicine. Why? Because without such knowledge he is likely every year to make hun-

Editor's Note: This ms. received in Laryngoscope Office and accepted for publication, July 28, 1948.

dreds of unhappy mistakes, to order scores of futile operations and to scare half to death hundreds of organically sound but worrisome patients.

The first thing that we physicians must do if we are to know psychosomatic medicine is to recognize that a large percentage of the patients that we see each day are ill mainly or solely because of an inborn hereditary tendency to nervousness, worrisomeness, abnormal and painful ways of thinking and constitutional trends. They have no demonstrable disease in the thorax and abdomen to account for the local distress.

The next thing to recognize is that we have been failing to help a high percentage of these patients, largely because we were not trained in college to recognize the typical syndromes of neuroses and partly because in attempting to diagnose puzzling problems we have came to judge them entirely from a thorough laboratory and roentgenologic overhauling. Such overhaulings are splendid and most helpful, and we must go on using them more and more, but we must always keep in mind that there is no test that will tell us that the woman sitting before us is dying of a broken heart, or suffering from a nervous breakdown due perhaps to an insane inheritance, or terrible overwork, or the breakup of a love affair or marriage, or the death of a loved one, or years of living with an abusive or alcoholic or unfaithful husband.

Perhaps the most important point the study of psychosomatic medicine has of late been bringing to the fore is that a high percentage of the illnesses that we physicians see every day are functional in nature and due to either poor nervous heredity or great strain and stress in life.

The next important point is that a nervous shock or a great strain can bring out not only functional disease but sometimes organic disease. Even in cases of gallstones many a colic follows a fit of temper.

The third important point and perhaps the most important of all is that even when a patient has some definite organic disease or the scars of such disease, as in cases of old coro-

nary thrombosis, most of the symptoms or all of them may be due purely to fear.

Today there is much need in medical practice for: *1.* greater skill in diagnosing functional troubles immediately from the history, and *2.* greater skill in ignoring incidental findings which cannot possibly be responsible for all the symptoms. Too often today the attempt to diagnose a neurosis by exclusion of organic disease fails because the examination turns up some inconsequential finding which is promptly accepted as the cause of the whole syndrome.

Every good physician who will take time to sit down and talk with his patient must become to some extent a psychiatrist. He has to.

Someone once said, very wisely, that anyone who is capable of opening an abdomen is a terribly dangerous man to let loose on the community unless he has some knowledge of psychiatry. Even an eminent consultant, if he comes to depend entirely upon the laboratory and fails to take adequate histories, will soon be making terrible mistakes, some of them costly to his patients.

One must learn the difficult art of telling a neurotic woman that her troubles are purely functional without making her angry, outraged and rebellious. One must talk to her with such sympathy, kindness and understanding that she will accept the diagnosis and go away determined to mend her ways and get well.

Most of us must learn something of the art of psychotherapy, the art of knowing what to say and what not to say to a patient.

Actually, with friendly, sensible treatment many neurotic persons can be greatly helped; they can be induced to start rebuilding their lives, and they can be taught to hoard their energy and become useful citizens again.

This whole paper should be read by every otolaryngologist. Practice of the principles enunciated would prevent many of

the disasters and disillusions that follow ill-considered nasal surgery.

The article concludes as follows:

Every physician must know much about psychosomatic medicine if he is to avoid many diagnostic mistakes, ordering many futile operations and scaring half to death many organically sound patients.

He must see that many of his patients are ill because of inborn nervousness, constitutional frailness, excessive worry or excessive strain. He must also see that none of the tests on which he relies for a diagnosis will reveal a neurosis or psychosis or nervous breakdown.

There is still great need for taking a good history and for sizing up the patient's story.

Many discomforts in the thorax or abdomen arise in the brain and are referred out to the periphery. Most of the feelings of chronic disease and ill health probably arise in the brain.

Some idea of the great importance of psychosomatic medicine can be seen from the fact that about one of every seven drafted men who passed a physical test had to be rejected for mental reasons; about one person in 13 in this country is insane or in need of psychiatric help, and one in 19 will eventually be committed to a state asylum.

The *British Medical Journal*[2] states that there is no satisfactory evidence that vitamin supplements, beyond what is required for a properly balanced diet, or "anticatarrhal" vaccines given orally or by injection have any prophylactic value against the common cold. If, on the other hand, there is evidence of a deficiency in any vitamin in a community, resistance to infection by the virus of the common cold and, more particularly, to secondary bacterial infection might be lowered; in which case vitamin supplements might serve a useful purpose. Thus, cod-liver oil or concentrates supplying vitamins A and D, and orange juice or its equivalent contain-

ing vitamin C, are given to babies and young children, whose requirements are relatively greater than those of adults. The prophylactic injection of vaccines containing influenza virus A and B has in controlled trials given encouraging results, although precautions may have to be taken to ensure that the vaccine contains the particular serological type of virus that is prevalent in the community at risk.

In the 25-year period[3] from 1920 to 1945 there were 26 officially reported milk-borne epidemics in Canada, each with 30 cases or more. These 26 outbreaks, attributed to consumption of unpasteurized milk, accounted for 702 deaths from typhoid fever, paratyphoid and septic sore throat.

In the same period there were numerous other lesser outbreaks of the same diseases and of undulant fever, also milk-borne. These minor epidemics also accounted for numerous deaths. For instance, there were officially reported 1,124 cases of undulant fever, an extremely difficult disease to diagnose, in the years 1940 to 1945. Twenty-three deaths were attributed to this disease in that period.

An interesting aspect of this milk-borne epidemic picture is the fact that since Ontario's adoption of compulsory milk pasteurization, there has not been one serious outbreak of a milk-borne disease in that province. Ontario is the only proving with such a law. On the other hand, the rest of Canada, since the 1938 enactment of the Ontario law, has suffered from 12 officially reported milk-borne outbreaks, chiefly septic sore throat and typhoid.

These facts would seem to provide additional proof that pasteurized milk is the only safe milk.

The *Journal of the American Medical Association* discussed[4] the effects of mineral oil as follows:

The use of mineral oil in foods such as imitation mayonnaise or salad dressing increased during the war because of the shortage of biologic fats and oils. Such food substitutes are used extensively also in weight reducing diets. Previous reports concerning the interference of mineral oil with the

absorption of fat-soluble vitamins, particularly vitamin A, and its precursor, carotene, were based mostly on animal experiments in which large quantities of mineral oil were used, compared with what would ordinarily be taken by man. Curtis and his associates showed that the ingestion of mineral oil by human beings will prevent a rise in blood carotene consequent to simultaneous intake of foods rich in carotene. The subjects in this experiment were observed for only 15 days.

Recently Alexander and his associates made similar observations on human beings for three to eight weeks. The results indicated that concomitant with the prolonged daily ingestion of mineral oil, either as such or in the form of mayonnaise dressing, at meal time, the plasma carotene concentration decreased about 50 per cent. Neither significant changes in the plasma vitamin A, nor untoward clinical manifestations occurred. The conclusion was that in man the simultaneous ingestion of mineral oil with food prevents substantial amounts of food carotene, a precursor of vitamin A, from entering the body.

While many physicians believe that mineral oil is not absorbable and therefore can do no harm, some of it prescribed for constipation does pass through the intestinal wall and on into the liver. Alvarez reviewed the work of Fraser, Stuart and Schulman, who found that if mineral oil was ingested without previous emulsification, only a small percentage of it was absorbed, but when given in the form of a fine emulsion, as many persons take it, about half of it went through the wall of the bowel. Absorption through the intestinal mucosa of rats and rabbits has been demonstrated histologically, biochemically and by actually counting the tiny oil droplets found in the blood which could be easily seen in the cells of the intestinal wall. Similar changes were found in the tissues of men and women who were known to have used paraffin oil; in fact, in 15 of 25 consecutive necropsies the lymph nodes revealed the presence of such drops of oil.

These observations raise the grave question, Alvarez says—

whether mineral oil can be used safely, year in and year out, as some persons use it. They also raised the question whether purveyors of food should ever be allowed to substitute mineral oil for the edible fats. The Council on Foods and Nutrition of the American Medical Association concluded in a report published in 1943 that the indiscriminate use of mineral oil in foods and cooking is not in the interests of good nutrition and that many such uses should be under careful supervision of a physician.

TREATMENT OF ACCESSORY SINUS DISEASE.

Some 10 years ago, Archer[5] commenced the treatment of cases of maxillary sinus suppuration (especially in children) by the introduction of an indwelling rubber catheter (of the de Pezzer type) into the maxillary sinus from the inferior meatus of the nose. Through this the sinus was irrigated with normal saline two or three times a day for seven to 10 days, and when repeated washings were returned clear, the catheter was removed. He was greatly interested, therefore, when some time later he discovered an article in the *Archives of Otolaryngology*, of 1926, by Alden[9] describing a similar procedure. He used short rubber tubes with a flange made for the purpose; irrigation was made with a bulb syringe, and the antrum was flushed with 1 per cent mercurochrome or 2 per cent silver nitrate solution. He recommended this daily irrigation until the sinus was free from secretion, usually a period of from 10 to 14 days.

The small operation is most satisfactorily performed under local anesthesia except in the case of young children, when a short general anesthetic is advisable. After cocainizing the nose, a Killian's speculum is introduced under the inferior turbinate, which is gently elevated until a good view of the nasoantral wall is obtained. Thornwaldt's trephine is placed in the position in which an antral puncture is made where the bone is thinnest. After one or two turns the trephine slips into the antrum. The trephine is then withdrawn and a de Pezzer catheter of suitable size is introduced through the hole so made. It is rarely necessary to enlarge this opening.

The catheter is fixed to the cheek with adhesive tape and its free end buried in a gauze pad to absorb any fluid seeping up from the antrum. The whole procedure is completed in one or two minutes. The following day, irrigation with warm normal saline is commenced by attaching the Watson-Williams syringe to the catheter and allowing the fluid to flow out through the ostium. After several irrigations the washings are returned clear and then the catheter is withdrawn, after which the hole closes in a few days and the normal anatomy and physiology of the sinus are restored.

The only mishaps encountered have been in three cases where the end of the catheter broke in the antrum (probably due to old and perished India rubber, as new catheters were not easily obtained during the war years). In two of the cases no difficulty was experienced in removing the broken off portion via the nose. In one case, a small child, it was necessary to open the antrum from the canine fossa.

The patients find this treatment in no way irksome and young children tolerate it perfectly well. Of course, in addition to this procedure, attention must be paid to other factors which may contribute to the chronicity of the condition. Any dental root infection must have attention, and in children, if there is a large adenoid mass interfering with efficient nasal respiration or harboring infection, removal is indicated. In adults, if there is marked deflection of the septum towards the side of the diseased antrum, a submucous resection operation may be required. In these circumstances infraction of the middle turbinate would appear to be necessary in most cases.

According to Scott-Moncrieff[6] most of the organisms responsible for sinusitis belong to the penicillin-sensitive group, although some individual strains among them may be penicillin-resistant or may become so during the course of treatment. Penicillin in the treatment of sinusitis should be, on the face of it, curative in the great majority of cases; however, this is not so, for there are many factors which compli-

cate the picture — factors which result from the peculiarities of nasal structure and function.

There are certain criteria for obtaining the maximum effect in the employment of any form of chemo- or biotherapy. All organisms, both aerobes and anaerobes, must be identified; the bacteria must be sensitive to the drug or drugs used; the drug must come in contact with the infecting organisms in the tissues in adequate concentration and over a sufficient period of time to allow complete bacteriocidal or bacteriostatic effect.

The above are general rules for this form of treatment, and there should be added another requirement in special reference to sinusitis: there must be adequate drainage or "ventilation." This applies to all forms of treatment of sinusitis, and is essential for proper chemotherapy also.

Parenteral administration is usually in doses of 15,000 to 20,000 units at three- to four-hour intervals. Occasionally results are very gratifying, but more commonly the disease is not greatly influenced, even when the dosage reaches astronomical figures. A number of causes may be mentioned to account for this inconstancy, such as: *a.* inadequate drainage with its resultant retention of the products of infection; and *b.* inadequate concentration of the drug where it can reach the organisms, because of poor blood supply from edema, pressure effects, permanent tissue changes in chronic conditions or because of the relatively poor blood supply of the mucous membrane of the sinuses.

There is one type of case in which this form of treatment alone does give remarkably good and constant results, and that is where the tissues beyond the confines of the sinuses have become involved, such as fractures into the sinuses from direct violence, and extension of infection, especially when it has involved the orbital tissues. In fact, in orbital cellulitis, the parenteral administration of penicillin seems to be the treatment par excellence, giving not only complete but also extremely rapid subsidence of the infection.

Very similar results are being obtained by the oral administration of the calcium salt given in larger doses.

The simplest form of administration of penicillin solution into the nasal cavity is by spray. An ordinary atomizer may be used as well as various more complicated methods, which aim at introducing into the nose a mist much finer than can be obtained from an atomizer. These are said to have a curative effect on many cases of sinusitis, but it is hard to understand how the drug, under these circumstances, is able to enter the sinuses unless some form of alternating suction or pressure is also applied. It would seem likely that not a few of these cures were really cures of rhinitis rather than of sinusitis.

It is reported that penicillin solution injected into the antrum will often clear up infection very rapidly. This is probably so, in that irrigations with common salt solution will frequently do the same thing. It makes one wonder if an accurate estimate has been made of the advantages of penicillin therapy. These are presumably cases in which the infection has not produced any great tissue changes, cases in which the infection has been more or less held in check by the natural defenses of the tissues, and the irrigations have turned the balance against the infection. It is hard to understand how a few cc. of 250 units per cc. of pencillin solution, which, after all, would remain in the sinus for a relatively short period, could clear up an infected antrum unless this infection was very superficial. For penicillin used thus must penetrate the tissues to reach deeply buried organisms.

DIAGNOSIS OF SINUS DISEASE.

Proetz[7] considers that the interpretation of roentgenographic shadows of the nasal sinuses requires care and time and a constant personal comparison between nose and film.

The more clinically important changes can be detected only in soft tissue shadows.

In training oneself to recognize the minor variations which

are so important, it is only common sense to demand a standard exposure technique, including time, voltage and angulation for each position. Long familiarity with films produced under such conditions alone enables one to detect the minor changes as they occur.

Changes in the bone are not the earliest manifestations of most nasal diseases; bone changes demonstrable by X-rays are apt to be late.

The demonstration of fluid levels in a sinus is dramatic. Fluid levels when seen during acute infections are of interest, but add little new information. They are of special value in chronic conditions.

On the whole, radiological evidence in acute inflammatory conditions is apt to be either inconclusive or superfluous. An acute infection of such severity as to produce demonstrable changes usually asserts itself vigorously and is located quite definitely by the patient.

As a check after the subsidence of the disease, also, the X-ray is less helpful in the nose than in other locations. If there is density while the patient is ill which clears when he recovers, then we are satisfied; there is no guarantee, however, that small abscesses or infected glands do not persist in the membrane which are a potential source of trouble. On the other hand, if the density persists after the patient is clinically completely recovered, we are not justified in doing anything about it for that reason alone, which leaves us exactly where we were.

If it should happen that the patient is not clinically improved and the clinical signs point to the offending sinus, then we proceed regardless of the X-ray shadows. If these are dense, we have learned nothing new; if they appear clear, we are still not assured that the sinus is unaffected.

Most useful to the rhinologist in his daily work are the shadow outlines of the membranes, since they give one a much more recent and a much more detailed account of what is going on. If the areas are fairly large or fairly dense, or

both, which is to say if they are fairly obvious, they can be diagnosed and evaluated without the aid of a radiopaque medium. A few roentgenologists who have shown a special interest in sinus work have developed remarkable proficiency in demonstrating and interpreting soft tissue changes in the sinuses. In his own experience small and important differences in the membrane outlines are very much better delineated by means of lipiodol or some similar contrast medium. Beyond this obvious advantage, the oils become an index to the ability of the sinus to empty itself — a piece of fundamental physiological information of great clinical use — which no amount of training can enable one to determine without them.

Radiopaques, by bringing them into sharp relief, greatly simplify the study of membrane outlines. Four things are to be noted: the characteristic outline of the membrane, the extent to which it follows the bone outline, the thickness of the membrane and its density.

ALLERGY.

Henderson and Rose[8] point out that recent trends in the study of allergic disease in man point to the release of a substance having many of the characteristics of histamine, if not histamine itself, which may be responsible for the production of symptoms. This has warranted the search for histamine antagonists. One of these, pyribenzamine, they studied in a group of 138 patients with allergic manifestations. Of these, 88 were relieved of symptoms, whereas 50 were not relieved. The most favorable results were obtained in the treatment of hay fever. Pyribenzamine had some undesirable side effects in a small percentage of patients treated, but these were not serious. It is apparently harmless in effective doses over long periods of time.

One of the commonest instances of drug allergy[9] is acetyl salicylic acid, or aspirin. It is also a very commonly used drug for relief of asthma, either alone or in asthmatic remedies. In addition to allergy, however, there may be intolerance to ordinary drugs. Morphine sulfate and codeine are almost uniformly poorly tolerated in asthmatics, and in the

opinion of these authors should not be used in asthma. Even if morphine quiets the respirations, wheezing may continue, and the slowing of the respirations tends to retention of bronchial secretions. Morphine is a dangerous drug in asthma and yet it is still frequently used.

Ward, Livingston and Moffat[10] present a preliminary evaluation of the radiation of the nasopharynx in the treatment of 34 proved cases of asthma in children.

These children were carefully studied from the otolaryngologic, allergic and pediatric point of view over a period ranging from six months to four years. Treatment consisted in irradiation of the nasopharynx with radon by means of a nasopharyngeal applicator. All forms of asthma were represented; 68 per cent of the patients obtained from total to 50 per cent relief, and 32 per cent obtained no relief.

The treatment of each child consisted of 2 gm. minutes of radon to each side of the nasopharynx — one each month for an average of four treatments. It is inferred that the same results can be obtained from the use of the Crowe-Burnam radium nasopharyngeal applicator.

After the treatments had been completed, observation of the nasopharynx showed that the lymphoid tissue had completely disappeared in 23 of the 24 cases. In the others, some lymphoid tissue still remained.

Special attention is drawn to the factors which precipitated the first attack of asthma. The first difficulty is normally encountered when one attempts to elicit the cause of the first asthmatic attack in any patient. Only by careful questioning can this information be obtained. The first attack of asthma in 22 of the 34 children was precipitated by a respiratory infection; for example, a common head cold, tonsillitis, pneumonia, or the respiratory infections which are so often a part of the contagious diseases of childhood. After the time when asthma had first appeared in these patients, it was possible to establish more accurate data. Five patients invariably had asthma after an infection of the upper part of the respira-

tory tract. No other explanation was found. In 16 patients, attacks developed after exposure to the common inhalants — house dust and animal danders or orris root and the common pollens. Three patients had asthmatic symptoms after the ingestion of a specific food. In the remaining 10, the symptoms developed after any combination of factors, which included respiratory infection, emotional upsets, too violent exercise and sudden changes in temperature which caused chilling or overheating. In fact, there were 18 children in whom asthmatic attacks developed with changes in temperature, and 12 of the 34 became asthmatic when they overexercised or were emotionally disturbed.

Irrespective of the specific causes mentioned, 27 of these children (80 per cent), subsequent to their initial attack, had an asthmatic attack after every respiratory infection.

The explanation of failures in a small series of cases is usually more difficult than is the explanation of success. In this group of patients, the examination of the nose and nasopharynx suggests, on the one hand, that failure to relieve the asthma was due to hypersecreting inferior turbinates or a deviated septum, which caused obstruction and congestion of the nose. On the other hand, successful treatment of the asthma was associated with complete disappearance of lymphoid tissue in 23 patients, as was demonstrated by nasopharyngoscopic examination. Naturally the question is raised: What type of asthma will diminish in frequency and severity after irradiation? Benefit was not confined to any single type of asthma and, conversely, in all types of asthma there was some benefit.

In the group of 23 successfully treated patients, five patients who had asthma due to extrinsic factors, such as the inhalation of dust, prior to the disappearance of lymphoid tissue were benefited as much by treatment as were the patients whose asthma followed an infection of the upper part of the respiratory tract and who were not allergic to any extrinsic matter.

The explanation is difficult. One may assume that infected

adenoids or lymphoid tissue acts as a "trigger mechanism," then synergistically precipitates an attack of asthma. Once the lymphoid tissue has been successfully irradiated, the absence of infection is the cause of the break in the usual cycle of the disease. Elimination of the offending extrinsic factors prior to irradiation treatment did not diminish the severity of the asthmatic attacks in these children, and thus the improvement following irradiation cannot be credited to removal of extrinsic factors alone but must be credited to the radon treatment.

These facts, though based on a small series of patients, are important since they show that irradiation must affect other mechanisms that enter into the production of asthma besides the reduction of lymphoid tissue.

The object of this report is to arouse interest in this new form of therapy, so that its larger use may prove and extend the true value that they consider evident from the results of this detailed study and from experience with hundreds of cases not included herein.

Shea[11] states that the impression is prevalent that all nasal polyps are allergic in origin. This is an exaggeration, but the opinion is uniformly shared by many of the younger surgeons.

Mucous polyps of the allergic variety are usually pedunculated and found most frequently in the middle nasal meatus, either originating from the ethmoid membrane or the middle turbinate. The age of the polyp determines its color and consistence. The epithelial covering is stratified squamous or columnar. The stroma is very loose and liberally infiltrated with exudate containing a few mononuclear cells, both large and small, the latter chiefly plasma cells. The number of eosinophiles varies and in polyps removed during an allergic attack will be numerous; whereas another polyp removed from the same nose during a quiescent state will be free of them. All allergic patients do not develop nasal polyps. Many hay fever sufferers go for years untreated and when the season ends, their nasal membrane returns to normal; whereas the patient with vasomotor rhinitis, who is sensitive to dust

and fungi and whose system is also disturbed by foods, constantly possesses them. The younger the individual, the more difficult it appears to be to prevent their recurrence, and in the author's experience the incident of fatal complications has been among young subjects.

Inflammatory polyps differ from the mucus type in that they contain less exudate and their cells are predominatingly polymorphonuclear leucocytes. Their distribution is not limited to the middle meatus as they may be found in the superior meatus. In this position they are dangerous, as their removal may open an atrium into the cranial fossae. These polyps are the result of vascular changes induced by chronic sinusitis. The inflammation is about the blood vessels producing a periphlebitis or a perilymphangitis.

The mulberry polyp is found on the posterior end of the inferior turbinate and consists of a hyperplasia of the turbinate tissue. Its glands are cystic and its blood vessels dilated.

In regard to pressure polyps, when the septum is deflected to impinge on the middle turbinate, sufficient pressure may be exerted upon the ethmoid capsule to cause a stasis of circulation and, as Woakes stated, produce a necrotizing ethmoiditis with the formation of polyps. The majority of solid tumors of the antrum are accompanied by ethmoidal polyps.

Choanal polyps arise either within the maxillary sinus or from the nasopharyngeal wall. The polyp is unilateral and becomes apparent when its size is a nuisance. Its epithelial covering is stratified squamous and its consistence solid. The blood supply is rich and any glands present are dilated. If the polyp originates from the maxillary sinus, the attachment is immediately within the sinus close to the ostium and best removed by a transantral approach. Those attached to the lateral wall should be removed by avulsion or destroyed by radium implants.

Various other nasal growths are discussed, one of which was a lymphangioma originating in the posterior ethmoid cells in a boy aged 12.

He concludes that the majority of polyps are allergic and simple, but there are enough serious growths to justify a thorough microscopic study of all polyps removed.

EFFECTS OF THE NEW DRUGS.

Since the indiscriminate use of the new antihistaminic drugs[12] has become so widespread, and may have harmful results, a critical inventory of their value is offered. The mechanism of allergy is briefly described and a historical and descriptive survey of the various remedies which have been employed for its control is given. These include the attempt to eliminate the antigen from the environment and ingesta; attempts to produce protective antibody by hyposensitization; the use of epinephrine and ephedrine to contract the capillaries and relieve smooth muscle spasm, as by aminophylline in asthma; and attempts to counteract the effect of histamine. Histaminase (torantil) is successful *in vitro*, but has not proved to be of clinical value, and an attempt to produce immunity to histamine by a histamine-protein compound (hapamine) has also been unsuccessful. Many of the compounds synthesized in Europe and America, following the demonstration by Fourneau and Bovet, in 1933, that certain phenolic ethers counteracted the action of histamine, have proved too toxic for clinical use. The most promising ones have been marketed under the following names: "antistin," "neoantergan," "pyribenzamine hydrochloride" and "benadryl hydrochloride." They counteract most of the physiologic effects of histamine, but do not chemically neutralize histamine nor prevent its production in the body. They are believed to compete with the histamine in its affinity for cells. Clinically their ability to inhibit whealing and to dry up mucus secretion is outstanding. Hence their conspicuous success in urticaria, where their efficiency it rated at 85 to 95 per cent, and hay fever, 70 to 80 per cent. In descending order of efficiency the author gives after these, vasomotor rhinitis, asthma, pruritus of eczema and contact dermatitis and migraine. The untoward effects are divided into side effects (dizziness and drowsiness in 20 to 50 per cent, dryness in mouth, head-

ache, nausea and vomiting, muscular twitching, paresthesia and dilated pupils); acute (one case only reported) and chronic (granulocytopenia) toxicity; and allergic symptoms (asthma, cough, dermatisis and urticaria, the last two being extremely infrequent). Prolonged administration has not so far resulted in any demonstrable organic damage either in human beings or in animals, and there is so far no indication of cumulative action or addiction. Their purely palliative effect must be recognized, but in this they are equal or superior to such agents as epinephrine, ephedrine or aminophyllin.

Orr[13] makes some useful observations regarding sulfonamides, penicillin and synthetic antihistamines.

The external application of sulfonamides is to be deprecated except in special circumstances. They have a high sensitizing potential and the sensitization so produced may prevent the later systemic use of the drug at a time when its use might be urgent. Their therapeutic effectiveness when used externally is not significantly greater than that of some other remedies with lower sensitizing properties and which are unlikely to be used systemically. The sulfonamides are still regarded as unsuitable as a rule for topical use in the treatment of diseases of the skin.

As many as 6 per cent of persons to whom penicillin is administered by one route or another may become sensitized, thus making it difficult and sometimes impossible later to use the antibiotic at a time when its administration might be lifesaving. It should, therefore, not be used as a topical application except in special circumstances and only after due consideration of its sensitizing possibilities. The same applies to the use of penicillin tablets or lozenges for minor infections for the prevention of possible infection following the extraction of teeth.

The success attending the use in Europe of antergan (dimethylaminoethylbenzylaniline) in controlling the itching produced in the skin by histamine led to the introduction in America of three chemically related substances, benadryl (Parke Davis & Co.), pyribenzamine (Ciba) and thenylene

(Abbott). Their effect apparently depends not on a chemical neutralization of histamine but on competitive inhibition. An excess of histamine compounds blocks histamine so that it cannot act.

Fenton and Larsell,[14] years ago, became convinced that, owing to the defensive factors inherent in sinus epithelium and the connective tissue elements of its tunica propria, almost every sort of surface application to such membranes becomes an irritant unless its strength be isotonic. More recently it has been found that dilutions, of certain new therapeutic agents, strong enough to inhibit bacterial growth were toxic to epithelial cells and fibroblasts, but that penicillin calcium proved inert as to cellular damage. After many clinical trials they are convinced that local use of this valuable antibiotic penicillin, as nose drops, is only justified in the very early stages of sinus involvement; that certain bacterial types are penicillin-resistant, while others may become so; that some individuals are allergic to penicillin; and that chronic infections are unlikely to be helped by such local applications.

To obtain histological evidence they infected a number of frontal sinuses of cats with a virulent hemolytic streptococcus culture of human upper respiratory origin. Study of the tissues showed the acute inflammatory reaction appeared to continue longer after local treatment with penicillin than in the earlier experiments in which no such treatment was employed. This suggests that the active stage of phagocytosis by polymorphonuclears is of longer duration and is, therefore, in all probability more effective.

For perfusion of acutely inflamed sinuses in human subjects and for intratracheal injection, they have found during the past three years that a solution containing 1,000 units per cc. gives rise to no complaint of local burning or irritation. This adds strength to the hypothesis that phagocytosis is greatly accelerated by the local use of penicillin.

Karelitz, Wasserman and Moloshok[15] report the result of studies in five hospitals on the application of penicillin in the treatment of diphtheria and diphtheria carriers as follows:

Patients with faucial diphtheria treated with antitoxin and penicillin, the latter injected intramuscularly every three hours until three, consecutive, daily, negative, nose and throat cultures were obtained, were rendered diphtheria negative more rapidly than were the patients who received antitoxin and no penicillin.

Carriers of virulent C diphtheriae were likewise rendered free of the bacteria by treatment with penicillin.

Penicillin applied locally in the form of nose drops or as nasal spray was not effective in faucial diphtheria but seemed more promising in the treatment of carriers.

Penicillin was ineffective in preventing toxic complications of diphtheria, but seemed to hasten the clearing and further the development of complications due to pyogenic organisms.

Penicillin should not be used as a substitute for diphtheria antitoxin.

PHYSIOLOGY.

Tremble[16] states that the knowledge of the physiology of the nasal sinuses accumulated in the past 25 years has changed entirely our mode of treatment in nasal infections.

He reviews and illustrates the distribution of the nasal cilia. The motion of the latter is whip-like, with a quick effective stroke in the direction of the flow of the overlying mucus and a slower recovery stroke in the opposite direction. When seen in profile, cilia appear to beat in sequence, forming waves which have been compared to a field of waving grain as the wind passes over it.

The movement of the cilia and of the sheet of mucus can easily be demonstrated by means of animal charcoal or lamp black. Dotted or sprayed in the nose, these innocuous substances can be followed with the aid of the nasopharyngoscope.

Two important points should be mentioned: *a*. that after removing completely the lining mucous membrane from the

patient's sinus, normal appearing and normal functioning mucosa complete with cilia regenerates in about five months; and *b.* that cilia beating vigorously are frequently found in cases of chronic sinusitis and even when bathed in pus.

For some years now, it has been known that certain drugs are harmful to the nasal mucous membrane. Many preparations used empirically in oily solutions by spray or dropper have been found to interfere with the action of the cilia. Menthol, camphor, thymol and oil of eucalyptus, to mention a few, tend to injure the mucous lining when used over long periods. As a result, mild shrinking agents which are isotonic, slightly acid, and do not interfere with ciliary streaming would seem most satisfactory from a physiological standpoint.

These findings suggest that an abundant supply of healthy mucus in the nose is more helpful than strong nasal medication. While it seems reasonable to assume that we should strive to eliminate pathogenic organisms, it is important to remember the normal protective mechanism of the nose. In short, our aim should be to preserve the natural defenses of the nose by ventilation and drainage, but it is also necessary to have the proper amount of moisture present, so that normal ciliary action is not impaired.

HEMORRHAGE.

Richardson[17] reports hemorrhage from the internal carotid artery following pharyngeal abscess, which was unique because two months elapsed between the initial retropharyngeal abscess and the final fatal hemorrhage.

A female patient, aged five, was admitted to hospital with a retropharyngeal abscess. This was incised in the normal manner and the child subsequently discharged from hospital as cured. A month later she was readmitted to hospital with a history of profuse nasal bleeding. On examination no area from which the bleeding had occurred could be found. The examination of the throat showed some residual swelling, but the mucous membrane over this swelling was of definitely healthy appearance. The swelling extended upward into the

nasopharynx but did not extend downward. The swelling did not cross the midline. As the past history was known and as the swelling was not marked, and as it was covered by normal mucosa, it was considered that the swelling was due to slight residual thickening following the retropharyngeal abscess.

The child was put to bed and kept under observation for some weeks. During this second period in hospital no further bleeding occurred. The child was discharged and sent home. She was readmitted again in two months from the first date with a history of another nasal hemorrhage. The hemorrhage had come on suddenly and was profuse. On admission to hospital, bleeding had stopped, but the child was pale, though her general condition was good. A few days after admission the child had another sudden hemorrhage and died before the doctor could get to her. A postmortem examination revealed erosion of the internal carotid artery.

The interesting feature of this case was the great lapse of time. Two months between the initial retropharyngeal abscess and the final fatal hemorrhage. As far as Richardson was able to ascertain, there is no instance in any of the other reported cases of such a long lapse of time between factual diagnosis of an abscess and the final fatal hemorrhage, or for that matter the first hemorrhage. Havens (*Am. Jour. Dis. Child.*, lviii) reported a case of a child, girl, aged six, who had been "ailing" for two months; when he saw the child, bleeding had occurred 24 hours previously. It is fair to assume that this child had not had a retropharyngeal abscess for two months. This case also died and a postmortem showed erosion of the carotid, high up on the postpharyngeal wall.

The main features of this symptom complex are: the patients are usually children between the ages of two and 10. Most common around five, although Insley reported a case in a patient 26 years old. The condition is most commonly preceded by a head cold, but it might also follow an attack of tonsillitis. There is very often present a cervical adenitis and there may or may not be some cervical swelling. Dysphagia is not infrequently present. Bleeding may occur before the

patient is seen or may occur after surgical intervention. There is nothing to suggest that surgical intervention might cause the condition, although Lifshutz in analyzing 21 cases showed that 12 cases occurred after incision. In by far the majority of cases, there is an initial warning hemorrhage. There is always present in these cases a retropharyngeal abscess. It is right to point out here that the Americans who have reported by far the greater number of cases speak of retropharyngeal abscess, a parapharyngeal abscess and a peritonsillar abscess. There seem to be definite anatomical and pathological grounds for this classification. A few of the rarer features reported include Horner's syndrome (Insley, *Jour. Laryngol. and Otol.*, Oct. 16, 1944), bleeding from the auditory meatus (Richards, *Ann. Otolaryngol.*, i, 1221). As a general rule, no area of hemorrhage or ulceration can be made out even after two or three attacks of hemorrhage. Clinical examination generally only reveals the abscess, which may or may not have been incised before bleeding has occurred. Sometimes when bleeding occurs into the tissues, a plum-colored mucosa is diagnostic.

Diagnostic points are:

a. Spontaneous hemorrhage which is so severe as to suggest that the bleeding has not occurred from a minor vessel.

b. Where the swelling does not completely subside after incision.

c. The presence of a hematoma as evidenced by a tense, brawny and plum-colored mucosa.

d. Increasing pain in the neck with local swelling and trismus especially after incision.

e. Presence of pulsation.

If any one of these signs is present in a case of bleeding from the nose or throat in a case of pharyngeal abscess, erosion of one of the carotids should be suspected.

The treatment of these cases is undoubtedly surgical, for more cases would end in death. Salinger and Pearlman

showed that the scales are heavily balanced against a patient who is denied operative interference.

Before the question of which artery should be tied, the following chart (Salinger and Pearlman) should be studied. It is a postmortem analysis of those cases on which postmortems were done.

	Erosion of Int. Carotid	Erosion of Ext. Carotid	Other Arteries	Common Carotid	Int. Jugular	False Aneurysm and Erosion of Int. Carotid
Peritonsillar abscess	7	0	4	0	0	4
Peritonsillar and parapharyngeal abscess	5	3	3	3	0	2
Retropharyngeal abscess	11	0	5	2	0	3
Retropharyngeal and parapharyngeal abscess	1	0	0	2	0	7
Parapharyngeal abscess	5	1	2	1	1	3
Cervical	1	0	0	1	13	0
	30	4	14	9	14	19

Thus in 90 postmortem cases the internal carotid was involved in 49 cases. The external carotid in four cases. Other arteries in 14. The common carotid in nine.

It should be pointed out here that the postmortem analysis showed that the main cause for jugular hemorrhage was cervical cellulitis following scarlet fever.

Thus it would appear that in most of these cases it would be advisable to tie the internal carotid or if the abscess is relatively low in the pharynx the common carotid should be tied. The end-result of operation in these cases is complete subsiding of symptoms with no residual hemiplegia. In one case reported by Pearlman, a contralateral facial palsy and hemiplegia which was present before operation, was cured by ligation of the common carotid. It is possible that the age of these patients prevents the appearance of untoward results that might occur in adults. In a few of the reported cases, multiple ligations were carried out. Pearlman ligated the common carotid twice in one case. Richards ligated first the common carotid, but subsequently ligated the internal and the ex-

ternal carotid on the same case because of the reappearance of bleeding. Both of these cases completely recovered. The reason as to why the internal carotid is so very often involved is probably due to the local anatomy of the parapharyngeal and retropharyngeal spaces and to the fact that the internal carotid lies normally closer to the pharyngeal wall than the external carotid. The internal carotid is often the site of aneurysmal dilatation and follows a tortuous course. Schaffer, in 1921, described a case of fatal hemorrhage during tonsillectomy due to an aberrant internal carotid artery. He claimed to know of three others. Carmack, in 1929, reported five deaths which were presumably due to the same cause. Thus the position of this vessel, its tendency to tortuosity and aneurysmal dilatations renders it more liable to be affected.

The unsolved question is whether infection is blood-borne or lymphatic. Since most cases of cellulitis following scarlet fever end as hemorrhage from internal jugular and as a blood-borne infection (thrombophlebitis) is most likely to cause a jugular complication, it is probable that the main cause is a lymphangitis which causes an adenitis of the glands lying along the carotid sheath. It should be pointed out that the highest of these glands belong to the retropharyngeal group of lymph glands, whereas the parapharyngeal space is occupied by glands found more in relation to the external and common carotid.

Macbeth[18] again draws attention to the value of the ligation of the anterior ethmoidal artery in certain cases of epistaxis.

While most cases of epistaxis cease spontaneously or can be controlled readily without operation, severe epistaxis can be one of the most troublesome emergencies and cases do occur where hemorrhage cannot be controlled by repeated packing, cauterization and transfusion. In such, the external or common carotid artery has been ligated and even this heroic measure has failed in some. The majority of surgeons have become obsessed by the idea that such epistaxis originates of necessity from an artery whose ultimate source is the external

carotid system and have forgotten that an important area of the nose is supplied ultimately from the circle of Willis.

On an anatomical basis epistaxis may be divided into two groups, depending upon whether it originates from the area of supply of one or the other of these main arterial systems.

While the branches of the sphenopalatine and ethmoidal arteries anastomose freely on and in the lateral nasal walls and the septum, the former on the whole supplies the lower and more posterior parts of the cavity, and the latter supplies the upper and more anterior parts.

The middle concha is a convenient landmark whereby we may determine the ultimate source of bleeding, and it is usually possible during an epistaxis to get some idea as to whether the bleeding originates from above or below this structure, in front of it or behind. When such an observation has been made, and when carotid compression has been tried, and assuming that simple remedies have failed, the operative course of action should be clear. Either the external carotid or the anterior ethmoidal should be tied. There is little point in ligating the internal maxillary artery via the transantral approach when the external carotid is so easy of access. It is assumed that failure of carotid ligation to control nasal bleeding has been due to anastomosis of vessels across the midline; but if carotid ligation fails, the reason is that the wrong arterial system has been interrupted, and in such cases ethmoidal interruption succeeds. The difficult cases from the point of view of diagnosis are those where the bleeding appears to come from the region of anastomosis of the two arterial systems.

In cases of head injury, there is often a fracture through the ethmoid, or through the frontoethmoidal suture, and this may involve the anterior ethmoidal artery or one of its main branches. These vessels lie in bony canals where they are subject to mural laceration or erosion, and where consequently they are unable to contract and retract. Thus, although they are quite small, the hemorrhage to which they may give rise is often considerable. In these cases bleeding may be imme-

diate or at an interval after the original accident; *i.e.*, it may be secondary in type, and presumably initiated by infection.

J. B., aged 12, was struck on the nose by the leg of a chair early in July, 1945. There was a slight bleeding from the left nostril. Four weeks later he had his left antrum washed out by a colleague in London because of infection. Soon afterwards he went on a Thames camping holiday, and on Aug. 14 received a trivial injury to the nose from his sister. He seems to have bled a good deal into the punt, and it was only next day that he saw a doctor who packed the nostril. He came into hospital, the packing was removed and there was no bleeding. Radiography revealed a fracture into the left frontal sinus and ethmoid. Next day he bled again from the olfactory cleft, though not severely. The anterior ethmoidal artery was occluded under local anesthesia, and the fracture was found to be actually involving the artery. There was no further bleeding.

Local infiltration by procaine or nupercaine is the method of choice; general anesthesia is to be avoided because of the danger of aspiration of blood into the lungs. Infiltration and incision proceed as for external ethmoidectomy. The periosteum of the orbit is elevated from its medial wall to a depth of about one and one-half inches from the nasal bridge, when the ethmoidal vessels will be seen passing in a cuff of connective tissue to the foramen in the frontoethmoidal suture. Retraction of the orbital contents defines the vessels, and a silver clip is applied to them. Any accessory vessels and the posterior ethmoidal vessels can be coagulated with diathermy needle, or simply clamped and torn across (indeed, diathermic coagulation may be all that is needed in the case of the main artery).

ANATOMICAL ABNORMALITIES.

Oldfield and Macnaughtan[19] were able to study and photograph the movements of the posterior pillars of the fauces from their posteroinferior aspect through a large pharyngeal fistula in a patient who some months previously had attempted

to commit suicide by cutting his throat. When he spoke, air escaped through the pharyngeal fistula and the effect on speech was similar to that resulting from the escape of air through the nose when the palate is cleft, as the explosions so necessary for consonant formation could not be produced. Direct observations were made of the soft palate and pillars of the fauces when certain consonant sounds were attempted. Not only was the soft palate raised but the posterior pillars were seen to contract actively and helped to occlude the nasopharyngeal isthmus.

They describe types of congenital abnormality of the pillars of the fauces and among these describe and illustrate congenital absence of the left anterior pillar of the fauces in a boy of 12.

They conclude that nasopharyngeal occlusion is effected by a complex sphincter mechanism composed of overlapping muscle slings. The posterior wall of the isthmus is drawn forward to form the ridge of Passavant, by the horseshoe fibres of the palatopharyngeal sphincter. The lateral walls are drawn inward by the salpingopharyngeus and the thyropalatinus (or lower fasiculus of palatopharyngeus). In front, the middle third of the soft palate is raised and drawn back into contact with the posterosuperior aspect of the pharyngeal wall; a valve is thus formed which occludes the already narrowed isthmus.

The posterior pillars of the fauces play a subsidiary but important rôle in speech and assist in the closure of the nasopharyngeal isthmus.

Blassingame[20] states that the embryologic background of lateral cysts and fistulae of the neck influence the clinical, or anatomic and technical problems associated with them. Wide divergence of views in regard to their derivation has created much uncertainty and confusion as to their surgical management.

Early observers believed that lateral cysts and fistulae of the neck were derived from the branchial apparatus. In 1913,

Wenglowski published a monograph disputing the possibility of the branchial origin of lateral cysts and fistulae, presenting evidence instead that these anomalies have their origin from persistence of parts or all of the thymus corridor.

He reports a case of a child seven years of age illustrating a complete lateral fistula of the neck, having its internal opening in the right tonsil at the upper pole, and its external opening at the anterior border of the right sternomastoid muscle near the sternal notch. In this case, the tonsil was removed with the fistula intact. He was unable to find in the literature another case in which a similar procedure was used.

TONSILS AND ADENOIDS.

Waldapfel[21] tries to show how much is known about the tonsils and at the same time how little. He says he has not even attempted to be complete.

(Comment: His bibliography does not contain a single reference to British or American papers.)

Walker[22] writes that analysis of the 1,779 cases in Ayrshire operated on for tonsils and adeniods in 1946 has shown that unsatisfactory results following tonsillectomy and adenoidectomy are due, in the great majority of instances, to the presence of chronic maxillary sinusitis, a condition which in children is often associated with night terrors, restless sleep, chronic cough, headache and pyrexial attacks of short duration.

Commenting on this analysis, Harpman[23] writes that in his experience systemic penicillin or sulfonamide therapy for chronic nasal sinusitis, while temporarily relieving some cases, has nearly always failed to cure them. Proetz's suction-displacement treatment he has also found disappointing. It has been his experience that the removal of tonsils and adenoids in cases of chronic sinusitis does not lead to its cure, that it is often more important to treat it than to remove the tonsils and adenoids, and that at any rate in very purulent cases it is best treated before this operation is done.

Kleinert[24] discusses premedication in tonsillectomies in children under six years old in an endeavor to evaluate the advantages and disadvantages obtained in administering preanesthetic sedation such as the barbiturates, and in substituting scopolamine for atropine previous to tonsil operations.

The evidence was obtained from a well completed study of about 200 children under six years of age operated upon with this premedication over a six-year period from 1940 through 1946.

The average time of induction was 20 to 25 minutes and the average time of operation was 20 minutes.

One of the disadvantages of the administration of the basal premedication for tonsil operations is that it increases the hazards. There is the necessity for a well trained staff of anesthetists. It is necessary for the surgeon to become familiar with the increased hazards and to learn to observe and to evaluate quickly any unfavorable change in the patient's condition. There is usually an increased time for induction. A disadvantage, also, is the administration of unnecessary drugs to children. The uncertainty of the reaction is another disadvantage. Two children of nearly the same age and weight may react quite differently to the same appropriate dosage. One will come to the operating room awake and talking, the other will be sound asleep. One will develop laryngospasm at the beginning of the anesthesia and another at the start of the operation, or when some blood comes in contact with the larynx. Some will breathe so quietly it is necessary to listen carefully to hear the respiration. This shallowness of respiration and laryngospasm are what cause the anoxia.

In cases of postoperative bleeding, there is danger of the child remaining too quiet, from drowsiness, during the afternoon following the operation.

There is the possibility of inhalation of blood into the trachea with chest complications resulting, if a patient is allowed to sleep quietly after the operation with the cough reflex abolished. A patient must be watched and turned frequently.

The advantages, from the standpoint of the anesthetist, are a quiet, nonapprehensive patient for induction. The advantage from the psychiatrist and the surgeon's viewpoint is postoperative amnesia when scopolamine is used. Children remain amnesic from the scopolamine for several hours.

The conclusions drawn were as follows: If basal anesthetics are used preoperatively in tonsillectomies, great skill and care are required to judge the dosage. It is necessary to have well trained anesthetists with experience in throat operations. The dangers from laryngospasm and anoxia seem very real. To obtain relaxation of the throat, as deep an anesthesia is required from the general inhalation anesthesia as if no basal premedication had been given. The disadvantages far outweigh the advantages. After five years of experience with this required premedication, he recommends eliminating the barbiturates given in combination with scopolamine as too depressing to respiration. Atropine can be used and a basal anesthetic in minimal dosage.

Macneil[25] asserts that those who suggest that the removal of tonsils in children is of doubtful value therapeutically are flying in the face of common clinical experience.

The operation of tonsillectomy when it is well carried out is attended with little morbidity or mortality, nevertheless there is one serious complication that must always be reckoned with; primary hemorrhage may be profuse and reactionary hemorrhage may occur within 12 hours following operation.

Hemorrhage is often attributed to deficient clotting; on this theory many types of serum and calcium medications have been advocated and used. Calcium compounds are a convenient and popular form of medication. The rationale of this treatment assumes that there may be a calcium deficiency, as it is well known that calcium plays a major part in the formation of blood clot. As low serum calcium is associated with obvious clinical symptoms, it seems unlikely that the concentration in children otherwise suitable for operation ever falls below the minimum required for efficient clotting.

Routine bleeding and clotting tests on all tonsil and adenoid operative cases he has discontinued.

The patient should not be sent from the operating room until all bleeding is controlled. Antiquated methods to accomplish this should not be used; there is no substitute for finding the bleeding points and ligating them.

Markham[26] reports that, in 1945, 15 cases of tuberculous cervical adenitis were treated at the country branch of the Hospital for Sick Children, Great Ormond Street. Shortly after admission, the tonsils and adenoids were removed and examined microscopically. The incidence of tuberculous infection of the tonsils was about 70 per cent, as might be expected from a study of the literature, but it was surprising to find that in this short series three cases showed infection of the adenoids. They are recorded because tuberculosis of the adenoids is rarely mentioned. In 1924, Crowe and MacCready, in an analysis of the pathology of tonsils and adenoids removed at the Johns Hopkins Hospital, noted that tuberculous lesions were present in 2.5 per cent of 1,000 cases of adenoidectomy. In these cases there was no clinical evidence of tuberculosis. No other record could be found of the incidence of tuberculosis of the adenoids in children. One case in an adult was described by Pégler in 1911.

In each of these three cases there was gross cervical adenitis in a child under two years of age, and the tuberculin patch test was positive. There was no evidence of tuberculosis of the chest or elsewhere, the weight was about the average or above the normal for the age, and the general health appeared to be good. Clinically there was very little enlargement of the tonsils and adenoids in the first two cases and no inflammation. In the third case there was some enlargement and inflammation of the tonsils during the early part of the illness. No information was obtained as to the origin of the infection in these cases. In none of them was the condition of the tonsils and adenoids such that their removal would have been advised on ordinary clinical grounds. It is probable that investigation of a larger series would reveal infection of these tissues to be more common than is generally supposed.

Treatment consisted in removal of the tonsils and adenoids, expression of glands in which abscess formation had occurred, and general care in the hospital's country branch. These cases are interesting in comparison with cases of streptococcal cervical adenitis. Here the child is pallid and debilitated, and often acutely ill, with enlarged red tonsils and nasal obstruction. In the tuberculous infection many glands may be grossly enlarged, but the child is relatively well and the tonsils and adenoids are small and pale.

Macroscopically the tonsils and adenoids were small and of a soft, firm consistency. Sections showed giant-cell systems and areas of necrosis typical of tuberculosis.

Crowe and Walzl[27] emphasized that the purpose of irradiation of the nasopharynx is simply to remove lymphoid tissue, and one can expect improvement of the condition to the extent that the adenoids are the offending agents, either by mechanical obstruction or by chronic infection. When carefully used as an adjunct to surgery and antibiotics, it offers a powerful therapeutic aid.

For the past 18 years Dr. Samuel Crowe and his associates have been using irradiation for the removal of surgically inaccessible lymphoid tissue in the nasopharynx. With doses too small to cause demonstrable effect on the mucous membrane, cartilage or glands, the lymphoid tissue may be caused to disappear, leaving behind smooth, normal appearing mucous membrane. During these years many thousands of treatments have been given and there have been no burns or other serious reactions.

Microscopic examination for adenoids which had been irradiated before removal shows that the action of the radiation is confined to the cells of the germinal centers. A few days after irradiation these cells show chromatolysis and fragmentation of the nuclei. Since the life span of the mature lymphocytes is only a few weeks, the mass of the adenoid tissue gradually shrinks, since there is no replacement from the damaged germinal centers.

Radium has been used as a source of radiation instead of X-rays because the applicator can be placed in contact with the lymphoid tissue and much lower doses with more local effect is obtained. With X-rays, to obtain the same dose for the adenoid, a much greater total dosage must be given because of the absorption of the rays in the superficial tissues.

The effective rays given off by radium are beta and gamma rays. Most of the beta radiation is absorbed in the surface layers of the tissues and therefore is more likely to cause erythema than the more deeply penetrating gamma rays. For this reason proper filtering of the radioactive capsules is necessary.

The advantage of the radon applicator is that much greater radioactivity can be obtained with it than with radium and thus a shorter period of treatment is required. The disadvantage is that the useful life of such an applicator is only about one week and then must be replaced; also, since the strength changes rapidly, the dosage must be calculated for each treatment.

The radium applicator contains about 50 mgm. of anhydrous radium sulfate and requires only an initial standardization; however, the applicator should be tested occasionally with an electroscope to be sure that a leak has not developed, allowing escape of radon gas.

It is, first, of the greatest importance to visualize clearly the nasopharynx though a nasopharyngoscope to determine whether or not treatment is indicated and to know exactly where to place the applicator. Small lymphoid nodules between the tubal orifice and the posterior end of the middle turbinate may be responsible for the symptoms.

It is now the carefully considered opinion of many otolaryngologists that infection of nasopharyngeal lymphoid tissue is a factor of the greatest importance in diseases of the respiratory tract and the ear. From the history alone it is apparent that in many patients recurrent infections of ear, nose and throat have their beginning in the nasopharynx.

Careful nasopharyngeal examinations and the results observed after elimination of infected adenoids have consistently confirmed this observation. Although this has been especially emphasized in recent years, it has been well recognized for a long time, as demonstrated by the frequency with which repeated surgical attacks on the nasopharynx have been carried out on children with persistent respiratory or aural disease.

Although radiation therapy for the elimination of adenoids has been used for over 20 years and many thousands of patients have been treated, few reports on the results obtained are in the literature.

Proctor[28] reports that during the past three years at the Hagerstown Clinic 400 patients have been so treated, and in most of them the results have been observed over long periods. The average period of observation for the total of 400 has been 13 months to date (June, 1946), and most of the more interesting cases have been followed for almost two years. A total of 1,110 radium treatments have been given to the 400 patients so far. There are 211 males and 189 females; 286 of the patients are between five and 15 years of age. As the treatment of these patients is not as yet complete, results must not be considered final, either for the bad or for the good.

These patients received, in addition to radiation therapy, surgical treatment of the tonsils or the adenoids when indicated (mastoidectomy or nasal operation in some instances) and local treatments to the sinuses, the nose or the ears.

The results are best considered under two headings: *1.* changes in the nasopharyngeal lymphoid tissue, and *2.* changes in the patient's symptoms.

At the latest examination, 99 patients had no lymphoid tissue in the nasopharynx, and in an additional 167 patients only minute traces remained.

At the first examination, 147 patients had lymphoid tissue completely covering the Eustachian orifices, and only 11 still had this condition on the last examination.

At the last test, the hearing of 234 ears had remained unchanged, the hearing of 284 had improved, and in only 24 had the hearing grown worse.

Of 33 chronically discharging ears, 12 healed completely during the period of observation, nine became dry though perforations persisted, and 12 continued to run. Of 94 patients who suffered from frequent acute aural infections, 71 ceased to have infections.

Of 178 patients subject to unusually frequent and severe acute infections of the upper respiratory tract, 113 stopped catching colds completely or had few, mild colds. Of 19 patients with bronchial asthma, nine no longer had attacks, and five others were markedly improved.

Seventy-six patients received only a single radium treatment; one patient had nine treatments and one patient had 10 treatments.

The *Journal of the American Medical Association*[29] states that irradiation of nasopharyngeal lymphoid tissue is now common practice. This form of therapy apparently has its greatest usefulness for the treatment of small collections of lymphoid hyperplasia in and about the pharyngeal orifice of the Eustachian tube which swell and produce edema within the tube and by this process produce secondary changes within the middle ear and hearing loss. In some instances this nasopharyngeal condition may account for congestive changes in the nose. Symptoms produced by the effect of hypertrophied adenoid tissue in small children have responded favorably to small amounts of irradiation. It has been used in children as young as two years of age.

Some of the first observations on the effect of irradiation of nasopharyngeal lymphoid tissue were made with applicators containing radon. This is not generally available, and it was found that radium filtered to provide the more caustic beta rays would give the same result. The beta rays are more caustic than the gamma rays but do not penetrate as deeply. With the use of the former, however, it was found that the

clinical result was the same on lymphoid tissue in contact with the applicator as compared with the gamma rays. The advantage of utilizing the beta rays lies in the fact that a small amount of radium is sufficient for a short period of irradiation.

Several companies now furnish applicators for this irradiation. The applicator is passed through the nostril until the radium is over the Eustachian orifice of the side to be treated.

With this method of application and dosage there is no danger of irradiating tissue outside the nasopharynx, such as the pituitary gland. The effect of this irradiation on the lymphoid tissue is not a grossly destructive one. It has been referred to as a biologic effect by S. J. Crowe, who has described the effect of irradiation as follows: "The action of irradiation is to inhibit mitosis in germinal centers and thus stop the formation of new lymphocytes. Observation of hyperplastic lymphoid tissue under this treatment leads us to believe that lymphocytes, like the skin cells, have a brief life cycle, probably not more than two weeks. Under irradiation treatment no new lymphocytes are formed to replace those discarded and the mass gradually shrinks and disappears."

The effect on any considerable amount of lymphoid tissue, however, is negligible, and surgical removal is indicated if there is any sizable mass of tissue.

POLIOMYELITIS AND TONSILLECTOMY.

Hamilton,[30] in a short essay on poliomyelitis, reviews the up-to-date medical teaching on this disease and emphasizes several points for the special elucidation of the otolaryngologist.

Poliomyelitis is a disease caused by a virus occurring in many strains. How it is spread, how the virus usually enters the body, how to immunize against it, and how to combat the virus *per se* is unknown. It is essentially a disease of warm weather. It tends to occur in epidemics. Originally more common in rural areas and in small towns, its incidence in

large cities has increased a great deal. The age incidence has gradually changed through the years. More recently older children and an increasing number of adults have been afflicted.

Its method of spread is not known. At present two theories on portals of entry are most favored; namely, the nasopharynx and the gastrointestinal tract. The former is the older theory and is supported by analogy with many other infections, by repeated isolation of the virus from the nasopharynx, by the irritation often found here early in the disease, by the demonstration of lesions in the cranial nerves and their nuclei, and by the fact that it is possible to infect animals by this route. Gastrointestinal entry offers many similar arguments, in that it also is a common portal for infections, by the fact that the virus may be isolated from stools and from the intestinal mucosa, by the existence of gastrointestinal symptoms early in the disease fully as often as throat symptoms, by the fact that incontrovertible milk-borne epidemics have been described, and further by the fact that at autopsy damage is found in all the abdominal and thoracic viscera, indicating a general involvement preceding and in addition to the characteristic changes in the nerve cells. A third possibility, less strongly supported but not excluded, is that an insect vector may be involved. This possibility hinges on the occurrence of the disease during the season in which insects are plentiful, plus the fact that the virus has been isolated from flies. None of these theories fits all the facts known about the disease and it may well be that there can be more than one portal of entry. At present, the gastrointestinal route is favored by most observers.

Since nothing that has ever been done by any health department has ever altered the course of an epidemic in the slightest degree, some states of the U. S. A. have already removed all restrictions on these patients.

Attempts to render the olfactory area impervious to the virus by treating it with cauterizing agents have been abandoned. The procedure caused considerable local irritation

and sometimes anosmia. In addition there came to be increasing doubt as to the nasal portal of entry.

The disease begins after about 10 days' incubation. The first symptoms may be those of an upper respiratory infection, a gastrointestinal upset, the ubiquitous "flu," or some combination of these. The patient is usually not very sick. His temperature is elevated but ordinarily it is not very high, and neither physical examination nor laboratory tests offer anything diagnostic. These vague symptoms may persist for a few days and disappear with complete recovery of the patient, or they may merge into the unrecognizable phenomena of nerve involvement, or they may disappear only to come again after about a week to form the biphasic or dromedary type of this disease.

Neural symptoms usually begin with stiffness of the neck, back or posterior leg muscles, singly or more often in combination, and with more or less lack of symmetry.

Concurrent with these changes or shortly after they appear, weakness begins and may exist in all degrees from the barely detectable to utter paralysis.

About a week after neural changes have begun, the fever and the constitutional symptoms disappear and no further damage occurs save in the occasional patient who relapses.

An innovation in the treatment is tracheotomy in certain cases with respiratory involvement. Since death in poliomyelitis occurs only from anoxia or conditions associated with it, it is obvious that these patients represent the most acute problems in the whole field of therapy.

Patients with bulbar lesions may have a variety of respiratory problems. Quite frequently the difficulty may be only in the throat, with inability to swallow, but with little or no true respiratory paralysis. These patients may be mistakenly put into respirators to their very great detriment. If they are given postural drainage plus suction as needed, they do very well, since paralysis of these muscles shows a high percentage

of recovery. Intrinsic laryngeal involvement also occurs, both with spasticity and flaccidity of muscles.

True respiratory involvement may include the chest muscles, the diaphragm, or both. Diaphragmatic paralysis is the more ominous. Candidates for both the respirator and tracheotomy come from this group.

Indications for tracheotomy are not clear-cut, and possibly they may never be. Physical signs of anoxia are scant in the early stages of the disease, and even when they are marked or can be accurately followed with the oxyhemoglobinometer it may still not be easy to determine whether these patients would be relieved by operation. It is certain, however, that death is often not due to failure of the respiratory muscles alone, but to this plus secondary changes in the lungs and the bronchial tree, such as mucus plugs, atelectasis, pulmonary edema and hemorrhage. Many of these can be approached via the tracheotomy tube and bronchoscopy, and at least an occasional patient may be given the added time needed to make a good recovery from this primary illness. His own clinic plans to report its recent experiences in the near future.

Undoubtedly the most vexing question regarding poliomyelitis for the otolaryngologist is the matter of the "closed season" on tonsillectomies at the time of an epidemic. Valid mass statistics on this question are almost impossible to obtain. It is hard to determine the number of tonsillectomies done in a large city in a given period of time, much less the number of cases of poliomyelitis; hence the relation of the operation to the incidence of the disease has been studied on the basis of admittedly incomplete data. At present one may question whether a tonsillectomy makes a subsequent attack of poliomyelitis any more probable. There are, however, impressive instances on record indicating that when such a subsequent attack does occur, it is much more likely to be of the bulbar type. Even if one refuses to admit the scientific worth of these instances, a thing hard to do under the circumstances, there still remain other factors not to be ignored. When one considers that tonsillectomy is seldom a very urgent

operation and when one also considers the public attitude towards this disease, it would seem emphatically the part of wisdom to postpone such an operation.

Pedersen[31] presents a statistical study of 492 cases of poliomyelitis following tonsillectomy hospitalized in San Francisco during 1941 to 1945. He concludes:

1. That the incidence of poliomyelitis to general population in an epidemic year (1941) was (ratio) 1 to 1,1960, while the incidence of poliomyelitis following tonsillectomy for the same period was (ratio) 1 to 1,782 (five cases in 8,910 known tonsillectomies).

2. That the incidence of poliomyelitis following recent tonsillectomy is not greatly out of proportion to the ratio of disease to the general population during an epidemic year.

3. That when poliomyelitis occurs following tonsillectomy it is more apt to be bulbar in type.

4. That there is a higher incidence of bulbar and bulbospinal type poliomyelitis in tonsillectomized patients than in nontonsillectomized patients, the ratio being two to one.

Winborn and Stansbury[32] say, that despite the many excellent and well written reports on poliomyelitis as influenced by tonsillectomy and adenoidectomy in recent years, the subject is still controversial.

In order to present further evidence on this subject, they studied 134 acute poliomyelitis cases admitted to Parkland Hospital, Dallas, during the first eight months of 1946.

They affirm that the facts they present confirm the conclusions of the more recent authors that the incidence of poliomyelitis in tonsillectomized individuals is no greater than in those individuals whose tonsils have not been removed. The danger of contracting poliomyelitis following recent tonsillectomy is minimal.

Cunning[33] carefully considers the evidence regarding the incidence of poliomyelitis in tonsillectomized patients. This

is of primary interest to the individual physician concerned for the safety and well-being of his patients. He shows that no one has produced the answer as yet. He strongly urges that another study be made to answer the question, "Are children on whom tonsillectomy is performed during the summer months more likely to contract poliomyelitis than non-tonsillectomized children of the general child population?"

When a correspondent asked, "What interval should be allowed to elapse from the onset of the last notified case of poliomyelitis before tonsillectomy can safely be undertaken?" the *British Medical Journal*[34] replied:

Notifications of poliomyelitis are increasing steadily and it would therefore be unwise to recommend tonsillectomy in any child who is living in an area — urban or rural — where cases are still occurring. The virus may persist in the feces of convalescent cases for three to four weeks, and be present for the same period in the sewage of the district where cases have occurred. Tonsillectomy should therefore not be carried out for at least four weeks after the last case has been notified.

The *Journal of the American Medical Association*[35] states that professional opinion regarding the performance of tonsillectomy during an epidemic of poliomyelitis is controversial. The weight of scientific evidence would indicate that, whereas surgery of this type does not materially influence the number of persons who contract poliomyelitis, the operative procedure does increase the likelihood that such persons will contract the bulbar form of the disease. The latter is particularly true when the surgery is performed just prior to or at a time when the person is harboring the virus.

It is generally held that it is safe to perform tonsillectomies and adenoidectomies when there is no evidence of poliomyelitis in the vicinity. Since epidemics of the disease occur during the middle and later summer and early fall, many health authorities recommend that, if a community is experiencing any increase in the incidence of poliomyelitis, purely elective surgery of the oropharynx and nasopharynx should be dis-

continued until the incidence of the disease has dropped, which usually occurs during late September and early October.

Priest, Boies and Goltz's [36] contribution to the treatment of poliomyelitis deserves study in its entirety, but it is so important that it deserves lengthy consideration.

This paper summarizes experiences with tracheotomy in patients with bulbar poliomyelitis treated at the University of Minnesota Hospitals and the Minneapolis General Hospital during the 1946 epidemic. During 1946, 1,830 cases of poliomyelitis were treated in Minneapolis. Almost all occurred during the epidemic period. Approximately 400 were diagnosed as "bulbar" cases. Tracheotomies were performed in 75 of these. Cases were classified as bulbar when the pharyngeal and laryngeal nerve supply was involved and also when there was circulatory and respiratory failure pointing to disease of the bulbar centers controlling these functions. In many patients spinal components were also present and in some, encephalitic involvement was suggested. Because poliomyelitis is a contagious disease, the patients were treated in only a few centers having isolation facilities.

Prior to this epidemic the staff members of the various departments involved had no experience with tracheotomy in poliomyelitis. Using the few published reports as a guide, tracheotomy was employed cautiously. As the epidemic progressed, the indications became clearer. They hope that a summary of their experiences may be useful to others.

As a result of their experience, they believe that tracheotomy has an important place in the treatment of bulbar poliomyelitis. In certain patients they think it is a lifesaving procedure. There is reluctance on the part of some physicians to accept tracheotomy as a useful adjunct in the treatment of poliomyelitis. Any physician whose experience with bulbar poliomyelitis encompasses only a few cases may question the need for tracheotomy; however, an epidemic in which several hundred bulbar cases occur produces a considerable number which meet the criteria for tracheotomy outlined in this paper.

In discussing the criteria for tracheotomy used in the 1946 Minneapolis epidemic, two groups of patients must be considered. One group includes patients over 14 years of age admitted to the neurology service of the University Hospitals. The second group includes pediatric patients at the University Hospitals and all poliomyelitis patients at the Minneapolis General Hospital. Criteria for tracheotomy for these two groups of patients were not identical.

On the adult neurology service at the University Hospitals they were requested to do a tracheotomy on any patient whose bulbar symptoms were early and whose disease was progressing rapidly, or who had evidence of involvement of the circulatory or respiratory centers, or who had severe toxicity or mental changes.

On the University pediatric service and on the contagious service at the Minneapolis General Hospital (both adults and children), the patient with bulbar poliomyelitis who had pharyngeal secretion into the larynx and trachea was subjected to tracheotomy only when he could not clear his own airway or when his airway could not be cleared for him by pharyngeal aspiration and postural drainage.

Inability of the patient to clear his own airway was indicated by recurrent cyanosis, coarse, bubbling râles in the chest, laryngeal stridor and inability to cough efficiently. These symptoms are most important in excited patients who are unmanageable and in stuporous patients. Direct laryngoscopy may demonstrate pooling of mucus in the pharynx, paralysis of one or both cords, and diminished tactile sensitivity of the laryngeal mucosa.

The second group of criteria discussed above apply when one does not feel justified in performing the operation prophylactically. They are not entirely satisfied that delaying the operation until positive indications exist is always best; however, the judgment of the physician enters the problem at this point and they feel certain that most tracheotomies in poliomyelitis will continue to be done only when definite indications exist. They feel strongly that a new concept as to what con-

stitute proper indications for tracheotomy in bulbar poliomyelitis should be created in the minds of physicians. They hope that this discussion will help to delineate this concept.

The use of the respirator in poliomyelitis patients having both bulbar and spinal cord lesions is contraindicated according to several writers because the machine may suck pharyngeal secretions down into the lower respiratory tract. Tracheotomy has been used in several of their cases to permit aspiration of this material from the trachea and bronchi.

Aspiration bronchitis and pneumonitis, anoxia and fatigue are the conditions to be minimized by keeping the airway clear.

When the patient with bulbar poliomyelitis coughs or is cyanotic after eating or drinking, the entrance of food into the respiratory tract must be suspected. Tracheal aspiration can only be provided by tracheotomy or repeated bronchoscopy. Such bronchoscopy is obviously not practical. It should be emphasized that according to competent pediatric opinion there is almost 100 per cent recovery of function of paralyzed pharyngeal muscles if life can be preserved in bulbar poliomyelitis through the first week of the disease.

Certain defense mechanisms which either normally bar the entrance of foreign substances into the trachea or aid in the eviction of such material are rendered impotent in some cases of poliomyelitis. The defenses in question are: normal vocal cord movement and normal sensitivity of the laryngeal mucosa.

When the motor innervation of the larynx has been damaged the exact position of the paralyzed cords varies. Coughing is normally carried out by bringing the vocal cords together in the midline, building up positive intrathoracic pressure, suddenly abducting the vocal cords and allowing the expiratory air blast to carry foreign material out of the trachea. Patients having weakened or paralyzed cords cough inefficiently. Decreased sensitivity or total anesthesia of the

larynx superimposed on an already damaged cough mechanism greatly increases the vulnerability of the trachea.

Patients having bilateral flaccid cord paralyses are unable to breathe deeply because their cords are pulled together by air entering the lungs during inspiration. As the cords are pushed downward by the inspiratory air stream, the glottic opening is narrowed. Continued breathing through a narrowed glottis is possible but difficult. Such breathing must be pathologically shallow to prevent asphyxia, because each really deep inspiration shuts off the airway. Such a fine degree of respiratory control is difficult or impossible in the excited, weakened patient with a damaged respiratory mechanism. Entrance of secretion into such a larynx is disastrous.

Transient anoxia is common in bulbar poliomyelitis patients. Of all body tissues, neural tissue is the least capable of withstanding oxygen want. This is especially true in poliomyelitis where the central nervous system is already damaged by the virus. The primary purpose of tracheotomy is to insure proper and constant oxygen supply. Weakness, fatigue, accumulation of secretion in the airways, and the toxicity resulting from the illness combine to hinder proper aeration of blood with resultant central nervous system anoxia. Just how much anoxia a particular patient's already damaged brain can tolerate is hard to determine. At the University of Minnesota Hospitals an oximeter employing photoelectric cells fastened to the ear lobe was employed to determine the degree of blood oxygenation. The usual clinical signs of oxygen want occur only when anoxia is already rather far advanced.

Early in anoxia combativeness resembling that of acute alcoholism may be present. Other symptoms include confusion, disorientation, irrationality and coma. Failure to recognize anoxia as a possible cause of these symptoms, and assumption that the polioencephalitis *per se* is the cause, may misdirect therapy. The administration of sedatives to such patients can be dangerous. Efforts to insure adequate oxygenation of the central nervous system often produce great improvement.

They used intermittent nasopharyngeal suction with the conventional type of portable electric pump despite the noise. Sometimes a nasal catheter was left in place and was moved about when aspiration was carried out. Leaving the tube in place spared the patient the discomfort of having it passed repeatedly. They emphasize that in the open pharynx one must move the catheter around to reach the secretion.

They consider that tracheotomy should be performed when the following conditions exist: respiratory distress as evidenced by recurrent cyanosis, coarse râles in the chest and laryngeal stridor; excitement and unmanageability, causing the patient to resist pharyngeal aspiration; stupor of a degree sufficient to make the patient oblivious of accumulation of secretion in his airway; inability to cough effectively; pharyngeal pooling of mucus, vocal cord paralysis, or intralaryngeal hypesthesia demonstrable by laryngoscopy.

As a result of their experience in that great epidemic they believe: *1.* that tracheotomy improves the chance for survival of properly selected bulbar poliomyelitis patients, if done before anoxia has produced significant central nervous system damage; *2.* that tracheotomy used in conjunction with various means for producing artificial respiration will enable some critically ill poliomyelitis patients to survive until natural recovery of damaged neural tissues can occur.

SURGERY.

Goodyear[37] states that early in his practice he watched patients suffer through prolonged painful acute fulminating frontal sinusitis. A new attack was adopted 10 years ago and this he describes and illustrates.

Frontal sinuses are not present at birth and do not usually give the rhinologist concern before eight to 12 years of age; however, near 12 years of age one most frequently sees acute fulminating infections of the frontal sinus following swimmining. Typically, within 12 to 24 hours following swimming, there occurs acute pain upon palpation, and swelling and edema about the eye, often closing the lids. The nose may be

swollen, and no secretion can be detected coming from the frontal sinus. The nasofrontal duct is closed; the pressure of fluid within the frontal sinus increases, the temperature rises, and a chill or chilly sensation may occur.

What is the most helpful procedure in these cases? Penicillin and sulfadiazine are indicated whether the treatment be surgical or expectant. One school may advocate rest in bed, cold compresses, Roentgen ray treatment, chemotherapy and no surgery unless complications occur. Courville states that subdural empyemas are four times as frequent in these primary acute cases as in acute attacks in chronic frontal sinus infections, death sometimes occurring within three or four days.

He believes fewer complications are likely and immediate relief of pain is secured by trephining the floor of the frontal sinus; however, this procedure must be guarded in its extent. Even the unnecessary elevation of the periosteum will cause a periostitis.

First, a roentgenogram is necessary before attempting any surgery upon the frontal sinus. One or both frontal sinuses may be absent in 16 per cent of adults.

A curved incision should be made just below the eyebrow and curved downward on a line midway between the inner canthus and the midline of the nose. A half-inch incision usually suffices, made under local anesthesia or sodium pentothal where general narcosis is desired.

The periosteum is incised but not elevated, and the opening in the bone is made with a nail trephine as is used in relieving the accumulation of blood under pressure under the fingernail. Those who have experienced such an injury to a finger know what a humane relief of pain trephining will give. The relief of pain in the frontal sinus is equally gratifying. A few half-turns of the trephine and the thin, noncancellous bone of the frontal sinus is penetrated and drilling continued to the desired size opening. There is a welling of pus or serous fluid under pressure. The cavity may be irrigated by means of a

10 cc. syringe and a large, blunt needle or cannula with warm saline solution plus penicillin if desired. A few folded strands of silkworm-gut may be used as a drain. Within 48 hours the drain can usually be removed, and the wound closes as the nasofrontal duct becomes patent. Rarely do complications occur.

If pus is found coming from the anterior middle meatus, usually trephining can be avoided or delayed.

It is important that the periosteum not be elevated following the primary incision through the soft tissues and the periosteum. Where periosteum is elevated, periostitis occurs and the danger of ostitis is greatly increased.

The point of the nail drill is placed in the periosteal incision, almost at a right angle to the sagittal plane of the nose, medial to the suprafrontal notch and just posterior to the medial orbital ridge. Trephining in this area is through thin bone and not in a direction toward the posterior frontal sinus plate.

(Comment: The reviewer's experience is that comparatively few children under 14 with acute frontal sinusitis suffer intolerable pain. They respond amazingly to the antibiotics.)

Cohen[38] describes an operation for the correction of dislocation of the septal cartilage. He has performed it on very young children. As he is not unaware that children's noses have to grow, he does not remove any cartilage unless he is sure it is absolutely necessary and then he removes little — only an anteroposterior sliver of the angle of deflection. A complete submucous resection in children is not advisable. The lower lateral cartilages are not interfered with. In time, these softer tissues may adjust themselves.

Anderson[39] describes a case in which a sphenopharyngeal encephalocele passed through the cribriform plate of the ethmoid bone and presented itself in the nasal cavity. Successful repair of this deformity was accomplished by the intracranial route, and details of this procedure are given.

Successful intracranial repair of similar encephaloceles has been reported by four other writers, and the end-result observed in each of the cases has been entirely satisfactory.

Several apparent cures have been reported in cases in which the treatment consisted in operating directly on the mass, with excision or snare removal; but in many instances fatal meningitis has followed the external operation, and it is concluded that this type of encephalocele is preferably repaired by the intracranial approach.

Intranasal encephalocele is probably more common than is generally believed. Since this protrusion resembles polyp and nasal fibroma, the possibility of encephalocele should be considered when a spherical mass is observed in the nose or the nasopharynx, particularly in infants or children.

The article is beautifully illustrated and should be read in the original.

Love and Gay[40] successfully treated three patients who had spontaneous cerebrospinal rhinorrhea by means of the intracranial surgical procedure described by Adson. One of these, a child, had a large bilateral defect in the cribriform plate, with a portion of the left frontal lobe herniating into the left nasal canal.

NEW GROWTHS.

In a richly illustrated article, New and Devine[41] discuss neurogenic tumors of the nose and throat. A number of these were in children. The article does not lend itself to abridgment and should be read in the original.

Because of its great rarity, Gibb[42] reports a fibroangioma of the ala nasi in a boy of two.

The patient was seen on Sept. 12, 1946, on account of epistaxis, following a blow on his nose on Sept. 8, 1946. Anterior rhinoscopy did not reveal any abnormality. He was ordered nasal drops of ephedrine hydrochloride 0.75 in normal saline.

On Nov. 21, 1946, he again attended the outpatient depart-

ment when the right nostril was filled by a tumor, dark red, bleeding on palpation, sessile, and attached to the inner surface of the ala nasi at the junction of the skin and mucous membrane.

On Nov. 22, 1946, a general anesthetic was administered, and the tumor was excised by means of two elliptical incisions around its base. There was a smart bleeding which ceased when the edges were sutured.

The report of the biopsy was that the section showed normal skin and fibroangioma.

A fibroangioma or bleeding polypus of the nasal septum is a rare condition and the occurrence of a similar tumor on the ala is still rarer. According to St. Clair Thomson it may occur between the ages of six and 70, but this one was in a child of two years.

The patient was last examined on Dec. 5, 1946, when the wound was found quite healed.

Figi[43] presents a comprehensive article on hemangiomas of the mouth. Three of nine illustrations are of children. The various forms of hemangiomas occurring about the lips and mouth are reviewed, and the treatment of these different lesions and of the phleboliths at times encountered in cavernous angiomas is discussed. In general, radiation is the treatment of choice for strawberry birthmarks and cavernous hemangiomas in infants and small children.

Cavernous hemangiomas of the lips and mouth in infants and children are best treated with radiation. Radon seeds of from 0.25 to 0.3 mc. each, implanted into the tumor and spaced approximately 1 cm. apart, usually produce satisfactory reduction with a minimum of deleterious effects. Such treatment can be repeated in from four to six months if indicated. While Roentgen therapy or radium packs will sclerose these cavernous lesions if applied repeatedly, their use is indicated in only the diffuse lesions of this type and in these they are applied to supplement interstitial radiation. Repeated external therapy is likely to produce pigmentation, telangiectasis and scler-

osis in the overlying skin which may interfere with subsequent development of the soft tissues and bony structures. Such unfortunate results are now being observed in some of the patients treated years ago by this method.

Slotkowski and Borovsky[44] report an adenoleiomyofibroma of the tongue in a nine-month-old Negro female infant. The mother had noticed only a few days prior to admission a small ball-shaped structure in the child's mouth, which flipped up from the base of the tongue when the infant cried. The infant had no difficulty in deglutition or respiration.

The mass was fleshy, smooth, polypoid, firm, about 1.5 cm. in diameter, attached by a pedicle to the base of the tongue in the midline. It was removed by snare and electrocoagulation of the base. Four illustrations.

Morwitz[45] states that lymphosarcoma of the tonsil is not common in the adult and is especially rare in the child. He gives in some detail various classifications of lymphoid tissue of the tonsil and then describes the course of a three-year-old child who had a lymphosarcoma of the left tonsil.

It was referred by his pediatrician on account of a rapidly progressive enlargement of the left tonsil in the last month. There was no pain or fever, but increasing respiratory effort. The left cervical lymph glands had become slightly enlarged but were not tender. The child now had a recurrent attack of nasal blockage with secretions, suggesting a nasal allergy. The mother had autumnal hay fever. Examination of the child on Aug. 9, 1945, revealed the nose filled with mucoid secretions, slightly enlarged, nontender left cervical lymph nodes, and an unusually large left tonsil almost closing the nasopharynx. The tonsil had a smooth surface, was uniform in outline, and on palpation was soft in consistency and did not bleed. The lips were dry because of mouth-breathing. The child displayed inspiratory difficulty on lying down. A ragweed skin test was negative. After suction the nasal tissues appeared edematous and pale.

A complicated problem presented itself. Tonsil surgery was

not permitted because there was a poliomyelitis epidemic prevalent at the time; the child had a nasal allergy with a family history of hay fever and the hay fever season was just approaching. In view of the fact that respiratory difficulty was increasing, a Roentgen therapy response would be too slow, and a biopsy was essential, not only for differential tissue diagnosis but also for adequate treatment, special permission was obtained from the hospital to allow a minimal general anesthesia for a rapid removal of the involved tonsil only. The operation was performed on Aug. 15, six days after the first examination. At operation, the capsule was found thickened and too adherent to remove hastily. Bleeding was readily controlled.

The biopsy report was hypertrophy and chronic inflammation of the tonsil tissue. At his request further study of the specimen was done, with the same diagnosis.

The child was re-examined one month postoperatively, at which time the left tonsillar fossa was found filled with a large, irregular friable mass, which bled at touch. There was increased enlargement of the cervical lymph glands on that side. The child looked pale and slightly cyanotic, and there was a secondary anemia. It was now quite obvious that the tonsil growth was malignant. The patient was rehospitalized and under the influence of only a narcotic a good portion of the friable mass was removed.

The biopsy report was as follows: Sections show a diffuse infiltration with mononuclear cells with fairly large nuclei containing moderate amounts of chromatin and varying considerably in size and shape. There are many mitotic figures. The reticulum is scanty; the blood vessels are rather numerous. Most of them, however, are of the sinusoid variety. There are no follicles. This picture is strikingly different from that seen in the previous biopsy. *Diagnosis:* Lymphosarcoma.

The child was immediately referred to the Chicago Tumor Clinic for Roentgen therapy. After six exposures failed to influence the tumor, treatment was discontinued. The patient

was then taken to the Mayo Clinic where, after a few ineffective Roentgen exposures, a tracheotomy was performed and the child discharged with a hopeless prognosis. On Dec. 3, the child, now *in extremis*, was admitted to the Wesley Memorial Hospital for a course of a duodenal extract substance for cancer on which research was being carried out there. Death occurred on Dec. 17, 1945, approximately four months after the first examination. Postmortem findings disclosed a generalized lymphosarcomatosis with lymphosarcoma particularly evident in the left superficial and deep cervical lymph nodes, in the left kidney and in the mesenteric glands.

Popov[46] reports three cases of myiasis of the nose, with a discussion of the causation, symptoms, pathological aspects and treatment.

Myiasis is any disease caused by maggots or flies. It is caused by the hatching of eggs laid within the nose by a fly. The foul odors of a chronic catarrhal inflammation, syphilitic rhinitis or ozena attract the fly. The latter requires to be in the nose only for a moment to deposit its eggs.

The pathologic effects of the disease consist of a more or less total destruction of the mucous membrane lining the nasal and accessory cavities of the nose. It is, in the early stages of myiasis, difficult to pick the larvae from the mucous membrane, as they seem embedded in the tissue, and the diagnosis may be difficult until the larvae appear, after which a mistake is impossible. The larvae denude the bone and cartilage, and in the later stages burrow through the thin bony plates. Whether the brain substance is softened by necrosis before or after is a question, but in cases that have resulted fatally great numbers of larvae were found in the brain substance. In many instances when the cerebral substance is infected the ventricles are found filled with bloody serum, or the meninges are found to be of a deep red color and filled with blood.

The treatment of this disease has been complicated by the ability of the maggots to survive in many antiseptic solutions. Experimentally it was found that a fully matured maggot

could live for four minutes in pure phenol, and for 15 minutes in strong turpentine. The maggot can crawl for several minutes over a surface strewn to a depth of one-eighth inch with pure mild mercurous chloride U. S. P. Chloroform was proved most satisfactory, as an exposure of 30 seconds to this atomized vapor invariably kills the worm. Solution of mercury bichloride 1:1,000 or a solution of formaldehyde U. S. P. diluted 1:10,000 may be used by injection.

Syringing or washing of the nasal cavities should be avoided, because the current might carry some of the eggs higher up into the nasal spaces.

He has used a 10 per cent solution of chloroform in milk as a nasal spray and removed the maggots mechanically with forceps from the nose at several different sittings each day. By such procedure the maggots are gradually removed from the nose. Sneezing will also dislodge great numbers of the larvae. Relief from pain and sleep could be induced when necessary.

A 14-year-old Mexican boy, a student by occupation, was admitted to the San Diego County General Hospital on Sept. 18, 1940. The patient stated that a fly flew into his left nostril on Sept. 15 and remained there for about 10 minutes before he could remove it. Two days later the patient began to bleed from his left nostril. This continued intermittently during the day with the gradual development of a frontal headache. On the morning of Sept. 18 he saw a private physician, who removed 20 maggots from his left nostril and sent him to the hospital. On admission the patient complained of pain over the left eye and left side of the jaw. Both nostrils were full of pus, there was edema over the left antrum and there was a foul odor coming from the nose. His temperature was 100.8° F., his pulse rate 110 and his respiration rate 24.

With the use of chloroform spray, 65 maggots were removed or expelled by the patient between Sept. 18 and 20. A roentgenologic examination of the sinuses showed a faint clouding of both antrums, more evident about the periphery

and compatible with mucosal hyperplasia. The ethmoid area also appeared clouded. The patient's temperature reached 105° F., his pulse rate 103 and his respiration rate 22 on Sept. 20. After this date the patient's condition began improving, and his temperature, pulse rate and respiration rate became normal in four days. The patient was discharged from the hospital on Sept. 30.

BIBLIOGRAPHY.

1. Alvarez, W. C.: Psychosomatic Medicine That Every Physician Should Know. *Jour. A. M. A.*, 704, Nov., 1947.

2. Answer to Query. Protection Against Colds. *Brit. Med. Jour.*, 1065, Dec., 1947.

3. Editorial Comment. Pasteurization Prevents Epidemics. *Canad. Med. Assn. Jour.*, 490, Nov., 1947.

4. Editorial: The Effects of Mineral Oil. *Jour. A. M. A.*, 512, Oct., 1947.

5. Archer, G. E.: The Treatment of Subacute Maxillary Sinusitis Especially in Children. *Proc. Roy. Soc. Med.*, 854, Dec., 1947.

6. Scott-Moncrieff, R.: Penicillin in the Treatment of Sinusitis. *Canad. Med. Assn. Jour.*, 296, Mar., 1947.

7. Proetz, A. W.: Evaluation of X-ray Evidences of Sinus Disease. *Canad. Med. Assn. Jour.*, 183, Feb., 1947.

8. Henderson, A. D., and Rose, B.: Pyribenzamine in the Treatment of Allergy. *Canad. Med. Assn. Jour.*, 136, Aug., 1947.

9. Editorial Comment. Drugs in Asthma. *Canad. Med. Assn. Jour.*, 490, Nov., 1947.

10. Ward, A. T.; Livingston, S., and Moffat, D. A.: Asthma in Children: Treatment with Nasopharyngeal Applicator. *Jour. A. M. A.*, 1060, Apr., 1947.

11. Shea, J. J.: The Pathology of Nasal Polyps and Related Growths. *Ann. Otol., Rhinol. and Laryngol.*, 1029, Dec., 1947.

12. Waldbott, G. L.: The Antihistaminic Drugs. *Jour. A. M. A.*, 207, Sept., 1947, as abstracted in *Canad. Med. Assn. Jour.*, 599, Nov., 1947.

13. Orr, H.: Recent Advances in Dermatology. *Canad. Med. Assn. Jour.*, 436, Nov., 1947.

14. Fenton, R. A., and Larsell, O.: Tissue Changes in Sinus Membranes After Penicillin Treatment. *Ann. Otol., Rhinol. and Laryngol.*, 245, June, 1947.

15. Kabelitz, S.; Wasserman, L. R., and Moloshok, R. E.: Penicillin in Treatment of Diphtheria and Diphtheria Carriers. *Jour. Pediat.*, 18, Jan., 1947.

16. Tremble, G. E.: Some Observations on Nasal Cilia. *Canad. Med. Assn. Jour.*, 255, Mar., 1947.

17. Richardson, E. C.: Hemorrhage from the Internal Carotid Artery Following Pharyngeal Abscesses. *Jour. Laryngol. and Otol.*, 604, Nov., 1946.

18. MACBETH, R. G.: Anterior Ethmoidal Hemorrhage. *Proc. Roy. Soc. Med.*, 280, Apr., 1947.

19. OLDFIELD, M. C., and MACNAUGHTAN, I. P. J.: Congenital Abnormalities of the Pillars of the Fauces and the Action of the Posterior Pillars and the Nasopharyngeal Valve During Speech. *Jour. Laryngol. and Otol.*, 594, Nov., 1946.

20. BLASSINGAME, C. D.: Congenital Cysts and Fistulae About the Head and Neck. *Ann. Otol., Rhinol. and Laryngol.*, 395, June, 1947.

21. WALDAPFEL, R.: The Tonsil Problem. *Arch. Otolaryngol.*, 318, Sept., 1947.

22. WALKER, F. M.: Tonsillectomy and Adenoidectomy; Unsatisfactory Results Due to Chronic Maxillary Sinusitis. *Brit. Med. Jour.*, 908, Dec., 1947.

23. HARPMAN, J. A.: Chronic Sinusitis in Children: Correspondence. *Brit. Med. Jour.*, 1054, Dec., 1947.

24. KLEINERT, M. N.: Premedication in Tonsillectomies in Children Under Six Years Old. *Ann. Otol., Rhinol and Laryngol.*, 168, Mar., 1947.

25. MACNEIL, F. A.: Primary Postoperative Hemorrhage in Tonsillectomy. *Canad. Med. Assn. Jour.*, 155, Aug., 1947.

26. MARKHAM, W. M.: Tuberculosis and Adenoids. *Brit. Med. Jour.*, 254, Aug., 1947.

27. CROWE, S. J., and WALZL, E. M.: Irradiation of Hyperplastic Lymphoid Tissue in the Nasopharynx. *Jour. A. M. A.*, 124, May, 1947.

28. PROCTOR, D. F.: Radiation Therapy for the Removal of Adenoid Tissue. *Arch. Otolaryngol.*, 40, Jan., 1947.

29. Answers to Queries. Irradiation of Adenoids. *Jour. A. M. A.*, 112, May, 1947.

30. HAMILTON, P. M.: Poliomyelitis and the Otolaryngologist. *Ann. Otol., Rhinol. and Laryngol.*, 161, Mar., 1947.

31. PEDERSEN, P. M.: A Statistical Study of Poliomyelitis in Relationship to Tonsillectomy. *Ann. Otol., Rhinol. and Laryngol.*, 281, June, 1947.

32. WINBORN, C. D., and STANSBURY, J. R.: Poliomyelitis and Tonsillectomy. THE LARYNGOSCOPE, 575, Aug., 1947.

33. CUNNING, D. S.: Tonsillectomy and Poliomyelitis. *Arch. Otolaryngol.*, 575, Nov., 1947.

34. Answer to Query. Poliomyelitis and Tonsillectomy. *Brit. Med. Jour.*, 237, Aug., 1947.

35. Answers to Queries. Tonsillectomies and Poliomyelitis. *Jour. A. M. A.*, 954, Dec., 1947.

36. PRIEST, R. E.; BOIES, L. R., and GOLTZ, N. F.: Tracheotomy in Bulbar Poliomyelitis. *Ann. Otol., Rhinol. and Laryngol.*, 250, June, 1947.

37. GOODYEAR, H. M.: Surgery of the Frontal Sinus. THE LARYNGOSCOPE, 340, May. 1947.

38. COHEN, S.: Dislocation of the Septal Cartilage. *Arch. Otolaryngol.*, 601, Nov., 1947.

39. ANDERSON, F. M.: Intranasal (Sphenopharyngeal) Encephalocele. *Arch. Otolaryngol.*, 644, Nov., 1947.

40. LOVE, J. G., and GAY, J. R.: Spontaneous Cerebrospinal Rhinorrhea: Successful Surgical Treatment. *Arch. Otolaryngol.*, 40, July, 1947.

41. NEW, G. B., and DEVINE, K. D.: Neurogenic Tumors of Nose and Throat. *Arch. Otolaryngol.*, 163, Aug., 1947.

42. Gibb, C. de W.: Fibroangioma of the Right Ala Nasi in a Boy Two Years. *Jour. Laryngol. and Otol.*, 459, Aug., 1946.

43. Figi, F. A.: Hemangiomas of the Mouth. *Ann. Otol., Rhinol. and Laryngol.*, 853, Dec., 1947.

44. Slotkowski, E. L., and Borovsky, M. P.: Adenoleiomyofibroma of the Tongue. *Jour. Pediat.*, 470, Oct., 1947.

45. Morwitz, S. M.: Lymphosarcoma of the Tonsil in a Three-Year-Old Child. *Ann. Otol., Rhinol. and Laryngol.*, 892, Dec., 1947.

46. Popov, N. P.: Myiasis of the Nose. *Arch. Otolaryngol.*, 112, Jan., 1947.

MISSISSIPPI VALLEY MEDICAL EDITORS' ASSN.

The Fifth Annual Meeting, Mississippi Valley Medical Editors' Association will be held at the Hotel Abraham Lincoln, Springfield, Ill., Sept. 29. This will probably be the last meeting under the above title as the Association's purpose will be enlarged and its constitution revised at Springfield. Dr. Vincent T. Williams, President, of Kansas City, Mo., Editor, *Jackson County Medical Society Weekly Bulletin*, will preside. In the afternoon, Dr. Morris Fishbein, Editor, *Journal American Medical Association*, will give a course in medical writing. There will be a fellowship hour, dinner and speakers in the evening, including Dr. Fishbein, of Chicago, and Dr. Waltman Walters, of Rochester, Minn., Editor-in-Chief of *Archives of Surgery* and the Lewis-Walters' Practice of Surgery.

Write Dr. Harold Swanberg, Secretary, W. C. U. Building, Quincy, Ill., for a complete program.

ARTICULATION TESTING METHODS.*

JAMES P. EGAN,†
Cambridge, Mass.

There are many reasons why oral communication may be inefficient or fail completely. Although failure to understand the spoken word is commonly due to failure of context to provide adequate meaning, there are many situations in which communication is ineffective because the listener confuses certain sounds with others, or because he does not hear them at all. Distortion of speech sounds by inferior transducers, masking of these sounds by ambient or electrical noises, faulty enunciation, partial deafness — all these factors and many others may conspire to make communication uncertain and unreliable. In order to evaluate the relative importance of the various factors that influence the intelligibility of speech, methods are required by which the degree of intelligibility of speech may be determined. These methods may be classified into three groups: articulation tests, subjective appraisals and threshold tests. The present paper concerns those procedures that have been found particularly useful in the measurcment of the intelligibility of speech.

A quantitative measure of the "intelligibility of speech" may be obtained by counting the number of discrete speech units correctly recorded by the listener in an articulation test. Typically, an announcer reads aloud lists of syllables, words, or sentences to a group of listeners, and the percentage of items correctly recorded by these listeners is called the articulation score. The scores obtained are dependent upon a large

*This paper concerns many of the methods used at the Psycho-Acoustic Laboratory for the study of oral communication during the war years. The research was begun under an OSRD contract and is continuing under contract with the U. S. Navy, Office of Naval Research (Contract N5ori-76). This is Report PNR-36.

†Now at the University of Wisconsin.

Editor's Note: This ms. received in Laryngoscope Office and accepted for publication, June 21, 1948.

number of factors that enter as parameters into every test. For convenience, these factors may be divided into two groups. One of these groups concerns the nature of the test items that constitute the discrete speech units. The other group of factors mainly concerns the procedures used in articulation testing.[1]

Although a quantitative measure of intelligibility is most completely informative, a qualitative evaluation is sometimes adequate. Frequently it is sufficient to have competent observers evaluate the quality of a given sample of speech. These observers may rank order various samples of speech in terms of the relative intelligibility of the samples, or they may describe the speech in terms of some standard of reference. If properly used, these "subjective" methods of appraisal can be employed to advantage. A brief description of these methods is included below.

For certain other purposes, it is of value to find the thresholds at which speech becomes just detectable, just perceptible, or easily intelligible. In determining these thresholds, the listener adjusts some variable, such as the intensity of a masking noise, until the appropriate threshold is reached. These procedures will be discussed later and typical results presented.

SPEECH UNITS FOR ARTICULATION TESTS.

In an articulation test the talker pronounces selected speech items and the listener records the sounds that he hears. Since the nature of the spoken items helps to determine the resulting articulation scores, the test material must be carefully selected if a proper assessment is to be made. For most testing purposes the speech sounds used should be reasonably representative of conversational speech. Furthermore, for economy of

1. For a discussion of the earlier methods employed at the Psycho-Acoustic Laboratory, Harvard University, see Stevens, S. S.; Miller, Joseph; Egan, J. P.; Waterman, T. H., and Rome, S. C.: Articulation Testing Methods, 1 February, 1942, OSRD Report No. 383. For a more detailed discussion of the present paper, see Egan, J. P.: Articulation Testing Methods, II, 1 November, 1944, OSRD Report No. 3802. (These and other OSRD reports are available through the Office of Technical Services, U. S. Department of Commerce, Washington, D. C., as PB 22916 and PB 22848, respectively.)

time and effort, it is important to group the speech units into balanced lists, each list as difficult as each other list. When lists of comparable difficulty are used, differences in articulation scores obtained with two different microphones, earphones, etc., may be interpreted as due to differences in the instruments rather than to differences in the difficulty of the lists.

1. Representation of Fundamental Speech Sounds. All, or nearly all, of the fundamental sounds into which speech can be analyzed should be represented in each list of test items. Ideally, the relative frequencies of occurrence of these fundamental speech sounds should reflect their distribution in normal speech. The desirability of a proportional representation in the test lists of the sounds that occur in everyday speech stems from a consideration of the problem of *validity*. A microphone which passed only certain types of sounds might test well with a list of words containing only such sounds, but the test would not be a valid indication of the usefulness of this instrument for ordinary conversation. For example, if a set of test lists contained no nasal sounds, it might not provide a fair test of a microphone coupled to the mouth by certain types of noise shields. As a practical matter, the actual distribution of sounds in speech depends upon whose speech it is and what is being talked about. It is possible, nevertheless, to state approximately the relative frequencies of occurrence of sounds in "average" speech, and to approach these frequencies in the distribution of sounds in each of the test lists. In any case, it must be remembered that such factors as the equipment and the type of interfering noise may alter the relative difficulty of different speech sounds.

2. Types of Test Items. Tests which measure how well speech sounds are recognized generally fall into one of three classes: *a.* single syllables made up of meaningless combinations of speech sounds; *b.* meaningful words given out of context as isolated units; and *c.* meaningful phrases or sentences, in which there are contextual relations among the words. The principal differences among these three classes depend upon the psychological factors of meaning, inflection, rhythm, etc.

Whether syllables, words, or sentences are used for testing purposes depends upon a number of considerations. The use of nonsense syllables has the advantage that the articulation score indicates more accurately the number of phonemes actually heard by the listener than do tests based on words or sentences. Also, it is quite easy to make up syllable lists of

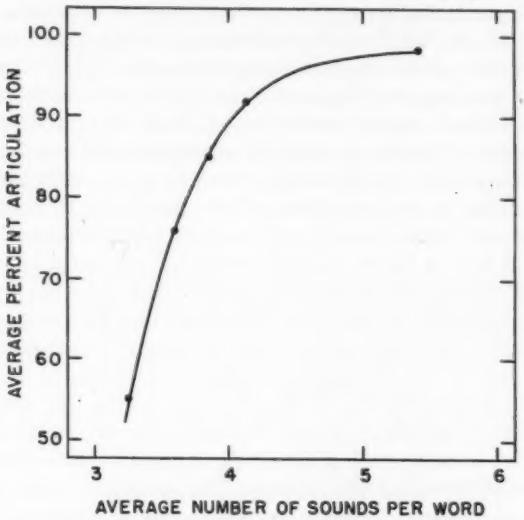

Fig. 1. Five groups of 20 words, having different average numbers of sounds per word, were read 20 times to a group of listeners. The graph shows how articulation improves when the number of sounds per word is increased.

comparable difficulty. On the other hand, the use of nonsense syllables requires that the testing crew be thoroughly trained. The announcer must pronounce the speech sounds correctly, and the listeners must record with phonetic symbols the sounds they hear. The use of words as test items does not have this disadvantage. There are large differences, however, in the relative difficulty of different words, and these differences cannot be attributed entirely to phonetic structure. Thus, short words are usually missed more frequently than

long words, and a test list can be made difficult or easy by varying the proportions of short and long words. Fig. 1 shows a relation between the number of words correctly recorded and the number of sounds contained in the words. This graph shows that articulation improves markedly when the number of sounds per word is increased. When the test materials consist of lists of sentences, and when these sentences are scored in terms of the meaning conveyed, psychological factors are still more important in determining the articulation score than when single words are used. For this reason, "discrete sentence intelligiblity" is typically higher than word or syllable articulation. Even when the listener is required to record the key words of a sentence, the percentage correctly recorded depends not only upon the articulation values of these individual words, but also upon the relation they bear to the other words of the sentence.

Since the difficulty of a test list is determined not only by the difficulty of the fundamental speech sounds but also by numerous psychological factors, it is desirable to demonstrate by actual test that each test list is as difficult as each other list.

For many purposes it is important to know at least approximately the relation between the scores obtained with various types of articulation tests. Such a relation makes it possible to predict from scores obtained on one kind of articulation test the performance to be expected on a different type of test. On the other hand, since the articulation obtained with any one type of material is dependent upon the difficulty of the items selected, there is no unique relation between the scores obtained with two types of tests. The particular relation will also depend upon other factors, such as, for example, the experience of the crew and the type of equipment used; however, within the limits of experimental error, it has always been found that, when syllable articulation increases, word or sentence articulation also increases. Fig. 2 shows one relation between word and sentence articulation. This relation shows that sentence intelligibility is higher than the corresponding word articulation.

3. Difficulty and Reliability of Test Lists. It is not suffi-

cient to make the relative frequencies of occurrence of the fundamental speech sounds correspond to those in conversational speech. In addition, the test items must be so selected that the distribution of item difficulty in each list will make possible a sensitive measuring instrument. Those items which under the conditions of the tests are always recorded cor-

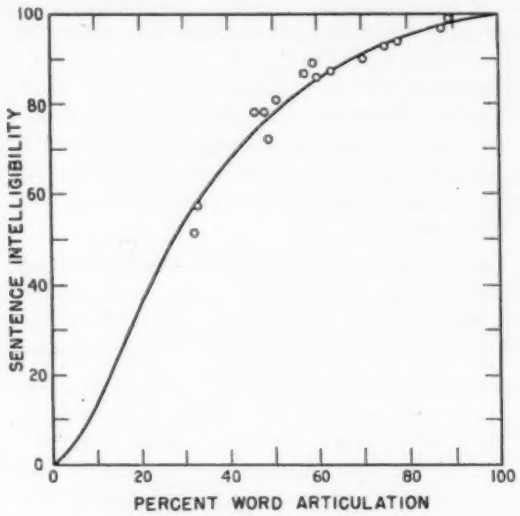

Fig. 2. Lists of words and lists of sentences were compared as to intelligibility under a wide variety of conditions. Each point on the graph represents one test of 100 words and one test of 50 sentences. The curve passing through the data was derived from results obtained at the Bell Telephone Laboratories.

rectly, or are always missed, are dead weight and may well be omitted from the test lists. There are, then, two potentially incompatible requirements for the distribution of test items with respect to difficulty, and compromise must be made between them.

a. If test lists are to be sensitive to small differences in intelligibility as well as convenient for use, the test items must be fairly closely distributed along a scale of difficulty.

b. Ideally, the distribution of difficulty should be sufficiently wide to embrace the requisite range as determined by the conditions under which the test lists will be used.

For an extensive testing program, it is convenient to have a large number of reasonably short and homogeneous test lists. When too few lists of words or sentences are used over and over, the crew of listeners tends to learn the particular grouping of items, even when the order of the items is changed each time a list is read. Short lists are desirable so that the articulation scores will not be unduly influenced by factors that tend to raise or lower the articulation score throughout the reading of a given test list. Fortunately, the reliability of the mean of a set of articulation scores can always be improved by increasing the number of tests.

The distribution of difficulty of the items in most tests follows a bell-shaped curve. For this reason, articulation tests are ordinarily not uniformly sensitive over the complete range of possible scores. The greatest sensitivity usually results when the testing conditions are so adjusted that scores near 50 per cent are obtained. This nonuniformity of the distribution of difficulty of test items implies that the variability of a test score is a function of the test score itself. Near the two extremes of the articulation scale (0 and 100 per cent) the variability of the scores is at a minimum, whereas in the middle range the variability is at a maximum; however, as mentioned above, when scores are obtained in the middle range, their reliability may be improved simply by increasing the number of tests.

AVAILABLE LISTS OF SYLLABLES, WORDS, AND SENTENCES.

Under each of the main types of test materials there are many varieties. For most purposes many of these different forms give equivalent results. For example, the *relative* effectiveness for masking speech of each of several different noises can be correctly assessed by the use of nonsense syllables, monosyllabic words, polysyllabic words, or sentences. Nevertheless, there are certain problems which are more efficiently

investigated by the use of one rather than another type of test item.

1. Syllable Lists. There are several forms of nonsense syllables. One form is obtained by permuting the consonants with the vowels. Examples of syllables formed in this way are *te* and *et*. Sometimes isolated vowels and diphthongs are included. Another form of nonsense syllable consists of an initial consonant, a vowel, and a terminal consonant, as in the syllables, *zed*, *mŏk*, and *tid*.

The construction of lists of nonsense syllables can be accomplished by a rather mechanical process. For example, one procedure followed by the Bell Telephone Laboratories[2] consists simply of drawing at random a card from each of three boxes. One box contains the initial consonants, one contains the vowels, and one contains the final consonants. Of course, certain of the syllables must be discarded: some of them are difficult to pronounce; some are very similar to other syllables; and some represent words that are taboo.

A word should be said about the selection of the phonetic alphabet employed for construction of lists of nonsense syllables. Such alphabets as the International Phonetic Alphabet make distinctions between certain phonemes which are far too fine and subtle for engineering purposes. It was found that the speech sounds in the Revised Scientific Alphabet[3] could be readily pronounced by the average speaker and consequently most of the sounds in that alphabet can be utilized.[4]

2. Monosyllabic Word Lists. In the course of its articulation testing program, the Psycho-Acoustic Laboratory constructed several sets of word lists. Since the editions and revisions through which these lists have gone are too numerous to describe here, we shall content ourselves with a

2. Fletcher, H., and Steinberg, J. C.: Articulation Testing Methods. Bell Syst. Tech. Jour., VIII, 806-854, 1929. It was the pioneering studies of the group at the Bell Telephone Laboratories which established articulation testing procedures as a basic method in the science of communication.

3. See Funk and Wagnall's Standard Dictionary.

4. The complete set of nonsense syllables which was used extensively at the Psycho-Acoustic Laboratory has been published as Appendix I of OSRD Report No. 3802, referred to in footnote 1.

description of the lists (PB) which represent the most recent revision.

From a large vocabulary 1200 monosyllabic words were chosen to make up what was called the RM (revised monosyllabic) lists. The exceptionally easy words were discarded from the original vocabulary, and only words in common use were retained. From this sample of 1200 words, 24 lists of 50 words each were constructed. The words were assigned to each list on the basis of the phonetic composition of the first part of the word. No attempt was made to equate these lists with respect to the phonetic structure of the final consonant or consonant compound. Although the RM lists were found reasonably satisfactory, the construction of a new set of word lists was undertaken to insure that the lists would be more nearly phonetically balanced (PB word lists). Every effort was made to make these new lists satisfy the following criteria: *a.* monosyllabic structure, *b.* equal average difficulty, *c.* equal range of difficulty, *d.* equal phonetic composition, *e.* a composition representative of English speech, and *f.* words in common usage. The PB series consists of 20 lists, each containing 50 monosyllables. They cover a wide enough range of difficulty to make them adequate for most types of articulation comparisons. The spread of difficulty is approximately the same in each list, and each list has nearly the same average difficulty.

Furthermore, the lists have very nearly the same phonetic composition, a phonetic composition quite similar to that of the English language. Rare and unfamiliar words have been avoided as much as possible, and very few of the words are extremely easy or extremely difficult under conditions in which the whole group of lists would obtain an average articulation score of about 50 per cent. Incidentally, it should be pointed out that each list contains 50 words because an attempt to satisfy the requirements listed above with lists of only 25 words met with failure.

The phonetic composition of the lists is based on Dewey's

frequency count[5] of the sounds in a sample of 100,000 words. It was found impossible to adhere strictly to the values given by Dewey, however, because of the limitations already imposed — namely, that the lists be all different and constructed of common monosyllables. According to Dewey, for instance, nearly 25 per cent of the words in his sample of 100,000 words began with short vowels. (This is due to the high frequency of such common words as *and, is, am.*) There are, however, only some 40 different common English monosyllables beginning with a short vowel. It was necessary, therefore, to limit this class of words to two per 50-word list. As a result of this and similar compromises, the resemblance of the phonetic structure of the lists to that of the language is not entirely exact.

The representation of sounds in each of the PB lists was made to follow as nearly as possible the distribution of sounds shown in Table 1. This table was derived from Dewey's counts (in compromise with the practical restrictions discussed above), and it shows the frequency of each phonetic class in each position in the monosyllables, initial, medial, and final. In each list there are about 10 compound consonants in the initial and about 10 in the final position. In Table 1 these compounds are classified in terms of the first consonant of the compound.

TABLE 1.
FREQUENCIES IN THE PHONETIC CLASSES IN THE PB LISTS.

Phonetic Class	Position of Sound in Word		
	Initial	Medial	Final
VOWELS			
Long	2	16	2
Short	2	20	2
Diphthong		6	
CONSONANTS			
Transitional	5		5
Semivowel	9		9
Fricatives	12		12
Voiced stop	9		9
Unvoiced stop	11		11

In the construction of the lists, adherence to the frequencies

5. Dewey, Godfrey: Relative Frequency of English Speech Sounds. (Harvard University Press, Cambridge, Mass., 1923.)

of Table 1 was found to be most difficult for the final sounds, usually because new words were not available which satisfied all the requirements. None of the lists, however, deviates by more than a few sounds from the specified pattern.

Earlier experiments had shown that similarity of phonetic structure is no guarantee of uniform difficulty among words. As a test of this matter, the words of the preliminary PB vocabulary were read eleven times under several conditions to a crew of eleven listeners, so that it was possible to obtain approximate measures of the relative difficulty of each of the words. A few words almost always missed by all the listeners, along with several almost never missed by any of the listeners, were discarded as nondiscriminating. Then, with the words remaining, every effort was made to equate the lists both for mean difficulty and for spread of difficulty.

Among the original words tested were a number fitting the phonetic specifications but very infrequent in spoken English (thong, fop, ilk, crass). Even if it comes clearly through an interphone, an unfamiliar word is likely to be missed. Consequently, the preliminary vocabulary was read in the quiet to 23 listeners who were instructed to rate each word as 1 (familiar), 2 (somewhat unfamiliar), or 3 (quite unfamiliar). The ratings for each word were added and all words with a total rating of 35 or over were discarded as too unfamiliar to be used. This seemed the most reasonable method available for eliminating unfamiliar words.

Since the PB word lists may be of value to other investigators, the 20 lists are appended below.

3. Spondaic Word Lists. There are purposes for which it is desirable to use lists of words of homogeneous audibility, *i.e.*, lists in which each individual word is as difficult as each other word. In order to assemble such lists, experiments were conducted in which various types of words were presented to trained listeners under carefully controlled conditions. It was discovered that the class of words having the highest homogeneity contained those dissyllables spoken with equal stress on both syllables. These words are called *spondees*. Examples

are *railroad, iceberg, horseshoe.* Word lists assembled from spondees have proved particularly useful in tests whose purpose is to establish accurately the level at which speech can just be heard. These homogeneous words reach the threshold of hearing, all within a narrow range of intensity, and thereby serve to determine with precision the threshold of hearing for speech.

In particular, the lists of spondees have been recorded phonographically for use as an audiometric test in the measurement of deafness.[6] The procedure for determining the threshold of a deafened ear has been greatly facilitated by recording the spondaic lists at decreasing levels of intensity on each record. The subject writes down the words he hears until the point is reached at which he can hear the words no longer. The level at which he hears half the words is usually considered the threshold of hearing for speech.

Similarly, these lists can be used to measure the relative efficiency of different earphones, or the effectiveness of different earphone cushions in coupling the earphone to the ear, etc. The electrical power required by an earphone to reach the threshold of hearing of a given ear is indicative of the sensitivity of the earphone as a transducer. *Caution:* since the spondaic words are much easier for a listener to identify than are the monosyllables (PB lists), they may sometimes be heard over a "peaked" transducer at a lower level (relative to a "uniform" transducer) than would be required for words chosen at random. Hence, the spondees are not recommended for use in the comparison of two systems which differ markedly in frequency response.

4. Sentence Lists. In testing communication equipment sentence articulation has a limited use. Under most test conditions articulation scores obtained with lists of sentences are so high that communication systems must differ considerably before substantial difference in the scores is obtained. As pointed out above, the intelligibility of sentences is favored

6. Hudgins, C. V.; Hawkins, J. E.; Karlin, J. E., and Stevens, S. S.: The Development of Recorded Auditory Tests for Measuring Hearing Loss for Speech. The Laryngoscope, 57, 57-89, January, 1947.

to a considerable degree by meaning, context, rhythm, etc. The influence of these psychological factors on the scores makes the results difficult to analyze and to interpret. Furthermore, since the listeners easily remember the sentences, a very large number of sentences is required in a testing program that employs the same listeners over and over.

There are, nevertheless, special circumstances in which sentence lists are of value. They are useful, for example, in testing the speaking ability of telephone talkers, where the utterance of a sentence provides a more complex sample of behavior than does the speaking of single words. Rate, intonation, stress pattern, and maintenance of loudness level can be tested adequately only with sentence material. Moreover, it has been observed in the course of experiments that talkers who are careless in their manner of uttering sentences may be more precise when speaking isolated words.[7]

The extensive set of sentence lists compiled at the Bell Telephone Laboratories[2] has been widely used by other laboratories. However, these lists vary considerably in difficulty, they frequently refer to details peculiar to New York City, and they are too much a test of knowledge and intelligence for use with some grades of listeners. Nevertheless, for quick appraisal of relatively poor communication systems, these lists of sentences provide a useful test material.

Another set of sentence materials available for use consists of 68 lists of 20 sentences each. Each sentence consists of five key words plus a variable number of connective words. Four of the key words are monosyllables and one is a dissyllable. An effort was made to avoid cliches, proverbs, and other stereotyped constructions, as well as the too frequent use of any one word in the lists of sentences. Since only the five key words in each sentence are scored, each list of 20 sentences contains 100 scorable items.[8]

7. Abrams, M. H.; Goffard, S. J.; Kryter, K. D.; Miller, G. A.; Miller, Joseph, and Sanford, F. H.: Speech in Noise: A Study of the Factors Determining Its Intelligibility. Psycho-Acoustic Laboratory, Harvard University, 1 September, 1944, OSRD Report No. 4023. (PB 19805.)

8. These lists are published in Appendix IV of OSRD Report No. 3802, referred to above.

Attention should be called also, at this point, to another set of sentence lists.[6] These are sentences whose comprehension can be indicated by the writing of a single word. They, like the spondaic lists, were specially devised to measure the degree to which an individual shows a hearing loss for speech. Ordinarily, sentences differ considerably with respect to the intensity level required to make them audible, and, since it is not feasible to achieve comparability by a process of selection alone, the sentences were made homogeneous by adjusting the intensity level at which a given sentence was recorded and reproduced. These adjustments were made experimentally with the aid of a crew of listeners. Then, for the final phonographic recording, each list was divided into small groups of sentences, and the intensity level of each group was successively decreased. The result of this procedure is a test which measures the threshold of hearing of a listener in terms of his ability to hear connected discourse.

METHODS OF CONDUCTING ARTICULATION TESTS.

The values of articulation scores are dependent upon a large number of factors. For example, the announcer introduces such variables as vocal quality, regional pronunciation, steadiness or variability of speech power, and other individual characteristics. If communication devices are used, the various components have their effects upon the intelligibility of the transmitted speech. Interfering noise — its presence or absence, its type, and whether it is introduced acoustically or electrically — makes for additional complications. And finally, the individuals comprising the crew of listeners differ from each other in their ability to hear speech under difficult conditions. In this array of factors are hundreds of small events — interactions among equipment, the sounds of speech, and the testing personnel — and each event contributes its small share to the overall result.

It becomes obvious, therefore, that the results of measurements of articulation cannot be interpreted in absolute terms. *All articulation scores are relative scores*, contingent upon the use of specific announcers, microphones, amplifiers, earphones,

noises, listeners, and test lists. Little trust can be placed in absolute statements about articulation. In general, the only trustworthy statements regarding the effectiveness of communication systems are relative statements.

This great complexity which attaches to articulation testing makes advisable a discussion of the specific factors contrib-

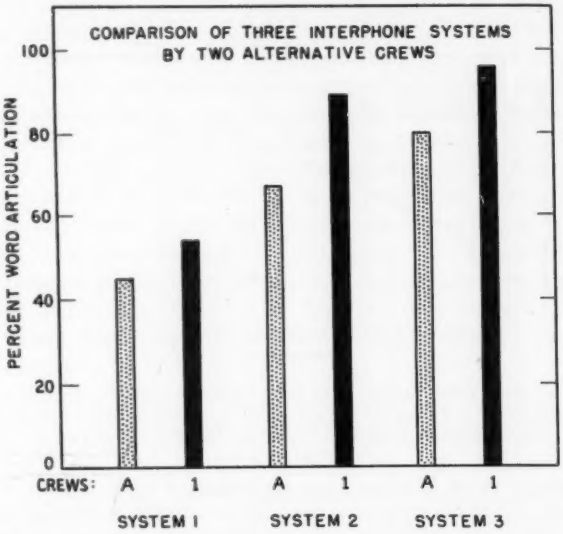

Fig. 3. Crew 1 was a trained laboratory testing crew. Crew A consisted of eight Army and Navy servicemen. All tests were made with announcer and listeners in an ambient noise (115 db). The rank order of the three communication systems as determined by the articulation scores is the same for both crews.

uting to the articulation scores and of the techniques used to control them.

1. Selection of Testing Personnel. In view of the large individual differences among talkers and listeners that are obtained under adverse conditions of communication, it is necessary to select carefully the testing personnel. For most purposes, the listeners should have reasonably normal hearing

and the talkers should have no speech impediments. Experience has shown that despite differences in abilities among announcers and listeners, the relative merits of various communication systems can usually be correctly assessed. Fig. 3 shows the articulation results obtained with two different crews of listeners. Three different interphone systems were tested with each of the two crews. One crew had been given very little training before this experiment was conducted.

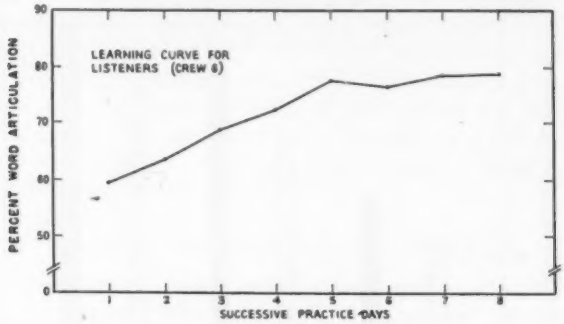

Fig. 4. Each point on the curve represents the average score on 12 tests of 100 words each with a crew of 10 listeners. The tests were read over an interphone system by three well practiced announcers. Both the announcer and the listeners were in an ambient noise (115 db).

The other crew consisted of experienced listeners trained in the laboratory. Although one crew obtained higher scores than the other, the three systems tested were ranked the same by both crews.

2. Importance of Training and Fatigue. Articulation scores obtained with inexperenced listeners show improvement with practice, and this improvement may be considerable under difficult listening conditions. Fig. 4 shows a typical learning curve obtained under severe acoustic stress. It is well to train a listening crew until little or no improvement results from further practice before comparisons are made among various communication devices.

In an experiment designed especially to measure the

effects of fatigue on articulation scores, tests were conducted throughout two experimental sessions of three hours each, one in the morning and the other in the afternoon of the same day.[9] In these tests, the listening crew was exposed to noise only for the interval required for the reading of the test list, and the listeners were given two 15-minute rest periods in each three-hour testing session. This entire procedure was repeated three days later, and the final results are based on both days. In all, 48 test lists of 100 words each were read to the listeners under two experimental conditions which were alternated from test to test throughout each day. For one-half the tests, both the announcer and the listeners were in an intense ambient noise (overall intensity level of 115 db); for the other half, a noise having a uniform spectrum was introduced electrically into the listeners' earphones. By combining the data collected on the two days of testing, it is possible to compare in Table 2 the articulation scores obtained during each of the six successive hours of testing. The low variability among these scores is evidence that articulation can be reasonably stable throughout the day. Fatigue seems to have little effect when reasonable provision is made for rest between tests.

TABLE 2.
AVERAGE ARTICULATION SCORES, HOUR BY HOUR, FOR TWO TEST CONDITIONS.

	T-17 Microphone (Ambient Noise)	BR-2S Microphone (Noise in Earphones)
A. M.		
1st hour	81	77
2nd hour	82	76
3rd hour	82	76
LUNCH		
P. M.		
4th hour	81	72
5th hour	78	78
6th hour	80	75

A temporary hearing loss acquired by listening to loud speech in the presence of noise seems to have no effect on

9. Egan, J. P.; Griffin, D. R.; Miller, Joseph; Waterman, T. H., and Stevens, S. S.: Performance of Communication Equipment in Noise. Psycho-Acoustic Laboratory, Harvard University, 1 October, 1942, OSRD Report No. 901. (PB22845.)

later tests using the same loud speech. However, if articulation tests using weak signal levels are conducted immediately after tests empoying painfully loud signal levels, the articulation scores obtained with the weak levels of received speech might be lower than the scores obtained with normal hearing.

3. Selection of Complementary Equipment. In comparing two devices with respect to the intelligibility of speech trans-

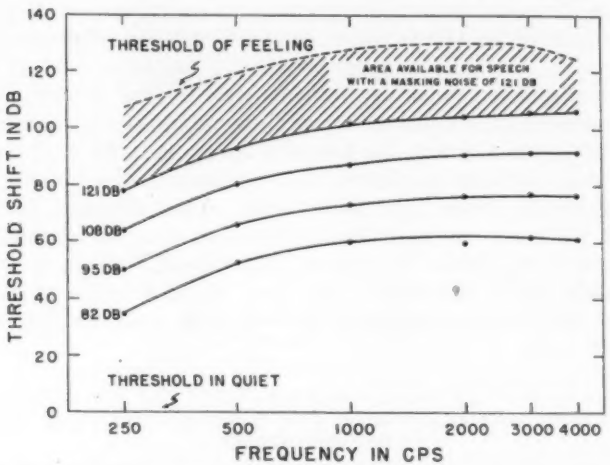

Fig. 5. These curves show how effectively a noise of uniform spectrum level (250-5000 c.p.s.) masks pure tones. The area between the curves representing the threshold of hearing in quiet and the threshold of feeling defines the auditory area available for communication in quiet. As the intensity of noise reaching the ear of a listener progressively increases, this area available for communication becomes smaller and smaller. The parameter values are the overall level of the masking noise.

mitted over them, it is important to consider the other components of communication equipment used for the test. For example, one microphone may not transduce speech frequencies above 2500 c.p.s. and another may transduce all the important frequencies of speech. If earphones which do not transduce speech frequencies above 2500 c.p.s. are used for these tests, little or no difference will be found in the articulation scores provided by the two microphones. Thus it may

be stated as a general rule that the final evaluation of an instrument cannot be made apart from a consideration of its associated equipment.[9]

4. Selection of Ambient Noise Conditions. A noise reaching the ear of the listener interferes with the intelligibility of

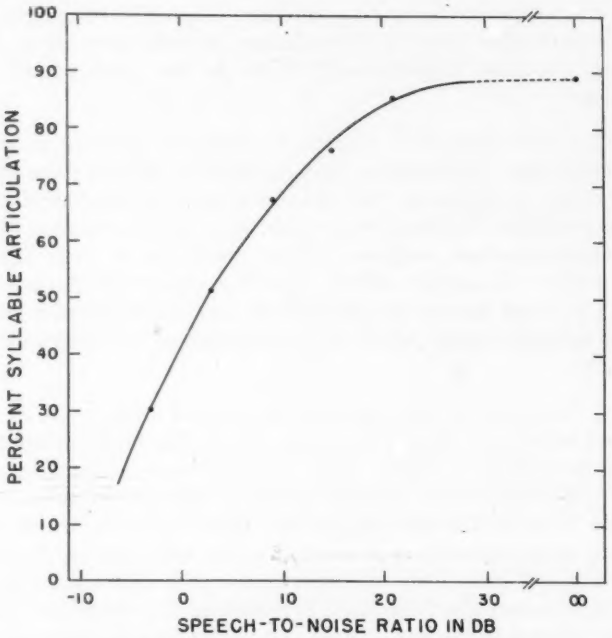

Fig. 6. Syllable articulation vs. speech-to-noise ratio. The speech level at the listeners' ears was held constant at a level of about 103 db overall. A "white noise" (random spectrum) was mixed electrically with the speech. Measurements of speech and of noise were made with a VU meter.

speech by raising the threshold of hearing so that sounds which could be heard in quiet are no longer audible. This shift in the threshold of hearing is called *masking*. The amount of masking produced by an interfering noise is the difference in decibels between the normal threshold and the

masked threshold for pure tones. Fig. 5 shows several masking curves obtained by using a noise which has a uniform spectrum level. These curves show how effectively a masking noise can reduce the auditory area available for the reception of speech. They also show why the intelligibility of speech depends upon the ratio of the level of the speech signal to the level of the interfering noise. Fig. 6 shows quantitatively how articulation varies as a function of speech-to-noise ratio.[10] The particular form of this relation depends upon many factors, the most important of which is the spectrum of the noise.[11]

If a communication system is typically used in a noisy environment, articulation tests designed to measure the intelligibility provided by that system should be conducted with the announcer or listeners, or both, in an ambient noise. Since microphones and earphones differ markedly in their ability to withstand acoustic stress, it is important that the evaluation of these devices by articulation tests be conducted under the acoustic stress which is representative of conditions of use.[9,12]

5. Intensity of Received Speech. Signal level is one of the most important determinants of the intelligibility of speech. For convenience, signal level in interphone communication may be considered a function of five principal variables: the voice level of the announcer, the efficiency with which the voice of the announcer is coupled to the microphone, the frequency response of the microphone, the gain of the interphone amplifier, and the frequency response of the earphone when it is coupled to the ear. These five variables are independent. In experiments designed to study the relation between articu-

10. Egan, J. P.; Miller, Joseph; Stein, M. I.; Thompson, G. G., and Waterman, T. H.: Studies on the Effect of Noise on Speech Communications. Psycho-Acoustic Laboratory, Harvard University, 25 November, 1943. OSRD Report No. 2038. (PB 22907.)

11. Miller, G. A.: The Masking of Speech. Psychol. Bull., 44, 105-129, March, 1947.

12. Waterman, T. H.: Flight and Laboratory Tests of Various Microphones and Noise Shields for Use at Low Altitudes. Joint report from the Aircraft Radio Laboratory (Memorandum Report 146) and the Psycho-Acoustic Laboratory, Harvard University (OSRD Report No. 1973), 27 December, 1943. (PB 22908.) Dr. Waterman's study shows that the articulation test is readily adaptable to the evaluation of communication devices in situ.

lation and the level of received speech it is usually practicable to vary only voice level or the gain of the amplifier. Examples of the relation between articulation and voltage gain of the amplifier are shown for three different microphones in Fig. 7.[13]

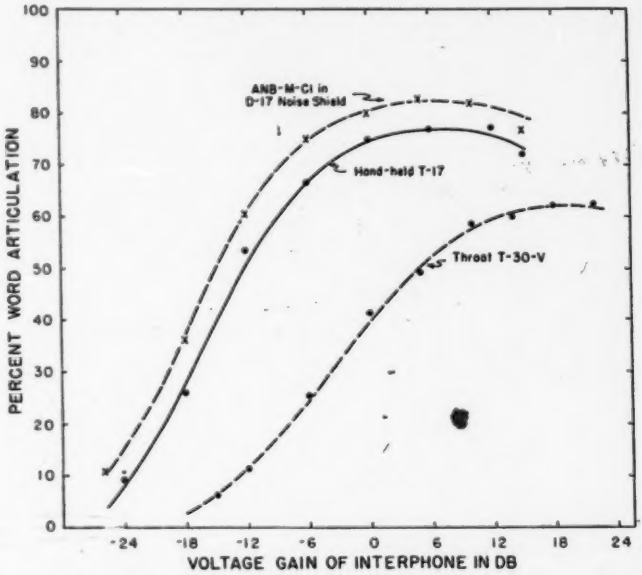

Fig. 7. Relation between per cent word articulation and voltage gain of interphone (linear system). The speech input to the microphone was held at a constant level throughout all the tests. Both the announcer and the crew of listeners were in ambient noise (airplane noise, 120 db).

Two examples of the relation between articulation and voice level are shown in Fig. 8.[13] For these experiments, the voice level of the announcer was varied over a wide range, while the gain of the amplifier was held constant.

In many experiments a system of monitoring the voice

13. Egan, J. P.; Stein, M. I., and Thompson, G. G.: The Articulation Efficiency of Nine Carbon Microphones for Use at Low Altitudes. Psycho-Acoustic Laboratory, Harvard University, 1 June, 1944, OSRD Report No. 3515. (PB 22913.)

which is independent of the system under test is desirable. By means of a magnetic throat microphone with an amplifier and output meter, a monitoring system is obtained which is satisfactory over a wide range of experimental conditions. The chief deficiency of this method is the difficulty of placing

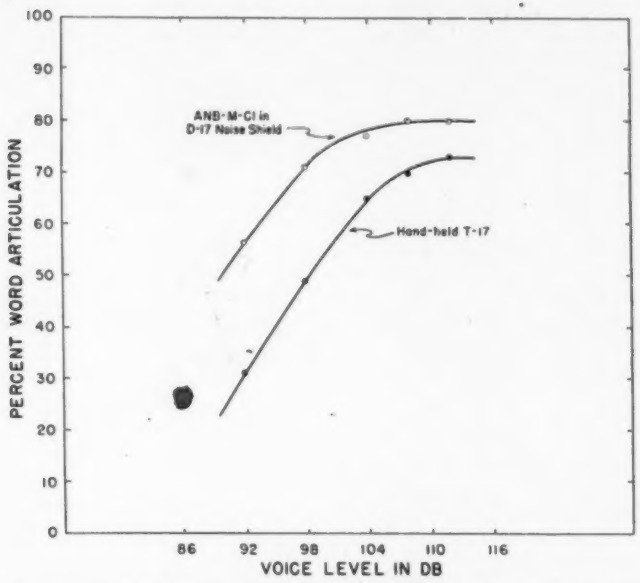

Fig. 8. Relation between per cent word articulation and voice level. The voltage gain of the interphone was held constant. The voice levels were measured by a GR Sound Level Meter (with the lips just touching the wire mesh of the microphone and the meter set to "slow" reading). Both the announcer and the listeners were in an ambient noise (airplane noise, 120 db).

a thoat microphone in the same position on the throat from test to test, but this objection can be overcome by the exercise of sufficient care. Carbon microphones do not provide a correct indication of changes in the voice level under typical conditions of testing. These microphones distort the speech signal and an effective compression occurs. Consequently,

changes in the output voltage of some, if not all, carbon microphones are not proportional to changes in voice level.[14]

6. Use of a Carrier Sentence. In an articulation test each test item (syllable or word) is usually read as part of a sentence. For example, in the sentence, "You will write *car*," the word *car* is the only word which the listener is required to record. A carrier sentence is desirable for several reasons. *a.* The listener is prepared for the presentation of the test item, and variability in the articulation scores due to inattention or distraction is reduced. *b.* If carbon-button microphones are used, the carrier phrase preceding the test item serves to agitate the particles of carbon and reduce the variability inherent in such microphones. *c.* The carrier sentence permits the announcer to modulate his voice so as to keep the level of his voice even from word to word.

For most purposes the carrier sentence and not the test item should be used to monitor voice level. Thus, no attempt should be made to compensate for the typical differences in the speech power used in pronouncing the different sounds in the test items. When only the carrier sentence is monitored, the test item should be spoken with the same general effort as the rest of the carrier sentence.

7. Statistical Methods. When an attempt is made to repeat articulation tests under identical conditions, the articulation scores obtained are usually somewhat different. If a test is repeated a large number of times, scores of various magnitudes are obtained. Unless the mean score is very high or very low, the scores tend to be distributed according to the normal law of error. The dispersion of the distribution of average scores obtained under the "same" conditions will depend upon how well the experimental conditions have been controlled. This dispersion also depends upon the number of listeners and the length of each test list.

The differences in the articulation scores obtained under the "same" conditions arise from many sources. In addition

14. Kryter, K. D.: The Effect of Voice Intensity on the Output Voltage of Various Microphones. OSRD Informal Communication, IC-74. This study is incorporated in OSRD Report No. 4023. See reference 7.

to systematic errors, there are in the array of basic factors determining the articulation scores many small events which contribute their small share to the overall result. The particular combinations of these chance events determine partially the extent to which the articulation score deviates from a central value. Since different combinations of these small events are sampled upon successive tests, different articulation scores are obtained. Differences arising from this source may be considered as errors due to random sampling. Because of these errors, an experiment must be designed so that differences between articulation scores may properly be analyzed by statistical procedures. The basic principle in experimental design consists in controlling at known values as many variables as possible, and in so arranging the experimental conditions that the effects of the unknown factors are made as random as possible. By this procedure the central or average articulation score can be interpreted in terms of the known conditions, and the dispersion of the scores can be used to determine the limits of accuracy imposed by the errors of random sampling. The dispersion of the articulation scores then becomes a measure of the precision of the experiment, and an estimate of the error of measurement may be based upon this dispersion. It is then a straightforward matter to assess, by conventional statistical procedures, the reliability of the differences obtained.[15]

ABBREVIATED TESTING METHODS.

The formal articulation test based on groups of announcers and listeners may prove too cumbersome and inefficient when an articulation study involves numerous permutations of experimental conditions. It is then expeditious to devise shortcut methods.

An interesting example of an efficient procedure is one which was developed to study the effects of amplitude distor-

15. Goffard, S. J., and Egan, J. P.: Procedures for Measuring the Intelligibility of Speech: Sound-Powered Telephone Systems. Psycho-Acoustic Laboratory, Harvard University, 1 February, 1947, PNR-33.

tion on articulation.[16] This method may involve a single individual. The test words are recorded phonographically, and good results have been obtained with the use of a single list used over and over.

The person conducting the test has before him a written list of the words recorded on the record. These words he keeps covered with a blank card. He listens to each word in turn, and, *after* he has both heard the word and decided what he thinks it is, he moves the blank card so as to uncover the correct word. He then checks whether or not he has heard the word correctly. This procedure obviously requires care and honest judgment on the part of the listener, but control checks applied to a practiced observer have shown that the method can be made to yield valid results. Since the listener, instead of writing down the words he hears, merely checks his correct responses, he is able to work at a fast pace and the speed-up in the articulation testing is considerable.

COMPARISONS BASED UPON SUBJECTIVE APPRAISAL.

In an articulation test the evaluation of the intelligibility of speech is based upon the *number* of test items correctly recorded by the listener. In this kind of test, the listener is not required to appraise the quality of the speech, but merely to record the speech sounds that he hears. By contrast, methods of subjective appraisal require the listener to evaluate the quality of speech itself. One variation on the subjective procedure is the *method of rank order*. The listener simply judges which of two or more samples of speech is more intelligible. Another variation is the *rating scale method*, which requires him to place a sample of speech along a continuum that has been defined in advance by the experimenter. For example, the listener might be asked to use a scale which ranges from very poor to excellent. The listener may make his judgments in terms of a standard sample of speech or in terms of his previous experience in the evaluation of the intel-

16. Licklider, J. C. R.: The Effects of Amplitude Distortion Upon the Intelligibility of Speech. Psycho-Acoustic Laboratory, Harvard University, 15 November, 1944, OSRD Report No. 4217. (PB 19775.)

ligibility of speech. This method is essentially the same as the method of rank order; however, in the method of rank order the intervals between the various ranks have no particular meaning. For example, the difference between ranks one and two does not necessarily have the same meaning as the difference between ranks two and three. In the rating-scale method the observer is usually instructed to rate the speech samples on a point scale where the successive points represent distances judged to be subjectively equal. He is not required to assign different ranks to the speech samples, nor is he required to utilize all of the points of the scale.[17]

THRESHOLD METHODS.

It is frequently desirable to know the conditions under which speech is just detectable or just intelligible. Three of these threshold methods will be described.[10]

To determine the *threshold of detectability* (sometimes called the threshold of audibility) the listener adjusts some variable (usually the intensity of speech or the intensity of a masking noise) until he is just able to detect the presence of speech sounds about half the time. At this threshold level he will ordinarily be unable to identify any of the sounds themselves. This threshold of detectability is the reference level for the specification of the sensation level of speech.

About 8 db above the threshold of detectability the listener can understand, with difficulty, the gist of connected discourse. This level of received speech is called the *threshold of perceptibility*. The determination of the threshold of perceptibility is useful when the intelligibility of speech can be varied continuously from a very low to a very high value. In determining this threshold the listener adjusts some variable until, in his judgment, he is just able to understand with considerable effort the gist of the connected discourse read to him.

In an effort to determine the reliability of this procedure

17. For a detailed discussion of these psychological scaling methods, see Guilford, J. P.: Psychometric Methods. McGraw-Hill Book Company, Inc., New York, 1936.

each of three listeners made 30 determinations of the threshold of perceptibility. A high-fidelity interphone was employed and a random noise with a uniform spectrum level was mixed electrically with the speech. The speech-to-noise ratio was adjusted by the listener until he obtained his threshold. The standard deviations of these three distributions of 30 judgments each were: 1.3 db, 1.6 db, and 1.7 db. The ranges of these distributions were only 6 db, 7 db, and 6 db, respectively. Furthermore, essentially the same threshold of perceptibility was obtained by different listeners. Eight inexperienced subjects made similar judgments after receiving only brief instructions in the procedure. Table 3 shows the speech-to-noise ratios that these listeners required in order to obtain the threshold. Each entry in the table is based on the average of three judgments. Only one of the eight listeners seems to have failed to adopt the correct criterion of judgment.

TABLE 3.
THRESHOLD OF PERCEPTIBILITY FOR INEXPERIENCED LISTENERS.

Listener	Speech-to-Noise Ratio in db
AM	—5 db
SM	—6
PP	—7
RL	—7
MR	—7
IP	—8
RA	—8
JS	+8

The average for the other seven listeners is —7 db, which agrees reasonably well with the average threshold obtained with four well-trained listeners (—5.5 db).

In determining the *threshold of intelligibility* the listener adjusts some variable until, in his judgment, he is just able to obtain without perceptible effort the meaning of almost every phrase of the connected discourse read to him. This particular threshold is probably less reliable than the other two; however, listeners generally agree that this threshold is about 4 db above the threshold of perceptibility.

These thresholds are useful in determining the relative effectiveness of various types of noise in masking speech. Determination of any one of these thresholds as a function of the intensity of the masking noise shows how the intensity of speech and the intensity of noise are related so that a constant perceptual effect is maintained.[18]

ACKNOWLEDGMENT.

The writer expresses his appreciation to Prof. S. S. Stevens for his invaluable advice and criticism during the course of this study. The writer is also indebted to those members of the Psycho-Acoustic Laboratory who contributed their efforts to the methodological problems of articulation testing during the war years.

APPENDIX.

In this appendix are presented 20 lists, each consisting of 50 common English monosyllables. These lists are phonetically balanced, and each list is very nearly as difficult as each other list.

PB-50 List 1

1	are	21	fuss
2	bad	22	grove
3	bar	23	heap
4	bask	24	hid
5	box	25	hive
6	cane	26	hunt
7	cleanse	27	is
8	clove	28	mange
9	crash	29	no
10	creed	30	nook
11	death	31	not
12	deed	32	pan
13	dike	33	pants
14	dish	34	pest
15	end	35	pile
16	feast	36	plush
17	fern	37	rag
18	folk	38	rat
19	ford	39	ride
20	fraud	40	rise
		41	rub

18. For an extensive application of one of these threshold methods, see Stevens, S. S.; Miller, Joseph, and Truscott, Ida: The Masking of Speech by Sine Waves, Square Waves, and Regular and Modulated Pulses. Jour. Acous. Soc. Am., 18, 418-424, October, 1946.

42 slip
43 smile
44 strife
45 such
46 then
47 there
48 toe
49 use (yews)
50 wheat

PB-50 List 2

1 awe
2 bait
3 bean
4 blush
5 bought
6 bounce
7 bud
8 charge
9 cloud
10 corpse
11 dab
12 earl
13 else
14 fate
15 five
16 frog
17 gill
18 gloss
19 hire
20 hit
21 hock
22 job
23 log
24 moose
25 mute
26 nab
27 need
28 niece
29 nut
30 our
31 perk
32 pick
33 pit
34 quart
35 rap
36 rib
37 scythe
38 shoe
39 sludge
40 snuff
41 start
42 suck
43 tan
44 tang
45 them
46 trash
47 vamp
48 vast
49 ways
50 wish

PB-50 List 3

1 ache
2 air
3 bald
4 barb
5 bead
6 cape
7 cast
8 check
9 class
10 crave
11 crime
12 deck
13 dig
14 dill
15 drop
16 fame
17 far
18 fig
19 flush
20 gnaw
21 hurl
22 jam
23 law
24 leave
25 lush
26 muck
27 neck
28 nest
29 oak
30 path
31 please
32 pulse
33 rate
34 rouse
35 shout
36 sit
37 size
38 sob
39 sped
40 stag
41 take
42 thrash
43 toil
44 trip
45 turf
46 vow
47 wedge
48 wharf
49 who
50 why

PB-50 List 4

1 bath
2 beast
3 bee
4 blonde
5 budge
6 bus
7 bush
8 cloak
9 course
10 court
11 dodge
12 dupe
13 earn
14 eel
15 fin
16 float
17 frown
18 hatch
19 heed
20 hiss
21 hot
22 how
23 kite
24 merge
25 move
26 neat
27 new
28 oils
29 or
30 peck
31 pert
32 pinch
33 pod
34 race
35 rack
36 rave
37 raw
38 rut
39 sage
40 scab
41 shed
42 shin
43 sketch
44 slap
45 sour
46 starve
47 strap
48 test
49 tick
50 touch

PB-50 List 5

1 add
2 bathe
3 beck
4 black
5 bronze
6 browse
7 cheat
8 choose
9 curse
10 feed
11 flap
12 gape
13 good
14 greek
15 grudge
16 high
17 hill
18 inch
19 kid
20 lend
21 love
22 mast
23 nose
24 odds
25 owls
26 pass
27 pipe
28 puff
29 punt
30 rear
31 rind (rīnd)
32 rode
33 roe
34 scare
35 shine
36 shove
37 sick
38 sly
39 solve
40 thick
41 thud
42 trade
43 true
44 tug
45 vase (vāce)
46 watch
47 wink
48 wrath
49 yawn
50 zone

PB-50 List 6

1 as
2 badge
3 best
4 bog
5 chart
6 cloth
7 clothes
8 cob
9 crib
10 dad

11 deep
12 eat
13 eyes
14 fall
15 fee
16 flick
17 flop
18 forge
19 fowl
20 gage
21 gap
22 grope
23 hitch
24 hull
25 jag
26 kept
27 leg
28 mash
29 nigh
30 ode
31 prig
32 prime
33 pun
34 pus
35 raise
36 ray
37 reap
38 rooms
39 rough
40 scan
41 shank
42 slouch
43 sup
44 thigh
45 thus
46 tongue
47 wait
48 wasp
49 wife
50 writ

PB-50 List 7

1 act
2 aim
3 am
4 but
5 by
6 chop
7 coast
8 comes
9 cook
10 cut
11 dope
12 dose
13 dwarf
14 fake
15 fling
16 fort
17 gasp
18 grade
19 gun
20 him
21 jug
22 knit
23 mote
24 mud
25 nine
26 off
27 pent
28 phase
29 pig
30 plod
31 pounce
32 quiz
33 raid
34 range
35 rash
36 rich
37 roar
38 sag
39 scout
40 shaft
41 siege
42 sin
43 sledge
44 sniff
45 south
46 though
47 whiff
48 wire
49 woe
50 woo

BP-50 List 8

1 ask
2 bid
3 bind
4 bolt
5 bored
6 calf
7 catch
8 chant
9 chew
10 clod
11 cod
12 crack
13 day
14 deuce
15 dumb
16 each
17 ease
18 fad
19 flip
20 food

21 forth
22 freak
23 frock
24 front
25 guess
26 hum
27 jell
28 kill
29 left
30 lick
31 look
32 night
33 pint
34 queen
35 rest
36 rhyme
37 rod
38 roll
39 rope
40 rot
41 shack
42 slide
43 spice
44 this
45 thread
46 till
47 us
48 wheeze
49 wig
50 yeast

PB-50 List 9

1 arch
2 beef
3 birth
4 bit
5 boost
6 carve
7 chess
8 chest
9 clown
10 club
11 crowd
12 cud
13 ditch
14 flag
15 fluff
16 foe
17 fume
18 fuse
19 gate
20 give
21 grace
22 hoof
23 ice
24 itch
25 key
26 lit
27 mass
28 nerve
29 noose
30 nuts
31 odd
32 pact
33 phone
34 reed
35 root
36 rude
37 sip
38 smart
39 spud
40 ten
41 than
42 thank
43 throne
44 toad
45 troop
46 weak
47 wild
48 wipe
49 with
50 year

PB-50 List 10

1 ail
2 back
3 bash
4 bob
5 bug
6 champ
7 chance
8 clothe
9 cord
10 cow
11 cue
12 daub
13 ears
14 earth
15 etch
16 fir
17 flaunt
18 flight
19 force
20 goose
21 gull
22 hat
23 hurt
24 jay
25 lap
26 line
27 maze
28 mope
29 nudge
30 page
31 pink

32 plus
33 put
34 rape
35 real
36 rip
37 rush
38 scrub
39 slug
40 snipe
41 staff
42 tag
43 those
44 thug
45 tree
46 valve
47 void
48 wade
49 wake
50 youth

PB-50 List 11

1 arc
2 arm
3 beam
4 bliss
5 chunk
6 clash
7 code
8 crutch
9 cry
10 dip
11 doubt
12 drake
13 dull
14 feel
15 fine
16 frisk
17 fudge
18 goat
19 have
20 hog
21 jab
22 jaunt
23 kit
24 lag
25 latch
26 loss
27 low
28 most
29 mouth
30 net
31 pond
32 probe
33 prod
34 punk
35 purse
36 reef
37 rice
38 risk
39 sap
40 shop
41 shot
42 sign
43 snow
44 sprig
45 spy
46 stiff
47 tab
48 urge
49 wave
50 wood

PB-50 List 12

1 and
2 ass
3 ball
4 bluff
5 cad
6 cave
7 chafe
8 chair
9 chap
10 chink
11 cling
12 clutch
13 depth
14 dime
15 done
16 fed
17 flog
18 flood
19 foot
20 fought
21 frill
22 gnash
23 greet
24 hear
25 hug
26 hunch
27 jaw
28 jazz
29 jolt
30 knife
31 lash
32 laugh
33 ledge
34 loose
35 out
36 park
37 priest
38 reek
39 ripe
40 romp
41 rove

42 set
43 shut
44 sky
45 sod
46 throb
47 tile
48 vine
49 wage
50 wove

PB-50 List 13

1 bat
2 beau
3 change
4 climb
5 corn
6 curb
7 deaf
8 dog
9 elk
10 elm
11 few
12 fill
13 fold
14 for
15 gem
16 grape
17 grave
18 hack
19 hate
20 hook
21 jig
22 made
23 mood
24 mop
25 moth
26 muff
27 mush
28 my
29 nag
30 nice
31 nip
32 ought
33 owe
34 patch
35 pelt
36 plead
37 price
38 pug
39 scuff
40 side
41 sled
42 smash
43 smooth
44 soap
45 stead
46 taint
47 tap
48 thin
49 tip
50 wean

PB-50 List 14

1 at
2 barn
3 bust
4 car
5 clip
6 coax
7 curve
8 cute
9 darn
10 dash
11 dead
12 douse
13 dung
14 fife
15 foam
16 grate
17 group
18 heat
19 howl
20 hunk
21 isle
22 kick
23 lathe
24 life
25 me
26 muss
27 news
28 nick
29 nod
30 oft
31 prude
32 purge
33 quack
34 rid
35 shook
36 shrug
37 sing
38 slab
39 smite
40 soil
41 stuff
42 tell
43 tent
44 thy
45 tray
46 vague
47 vote
48 wag
49 waif
50 wrist

PB-50 List 15

1 bell

2 blind
3 boss
4 cheap
5 cost
6 cuff
7 dive
8 dove (duv)
9 edge
10 elf
11 fact
12 flame
13 fleet
14 gash
15 glove
16 golf
17 hedge
18 hole
19 jade
20 kiss
21 less
22 may
23 mesh
24 mitt
25 mode
26 morn
27 naught
28 ninth
29 oath
30 own
31 pup
32 quick
33 scow
34 sense
35 shade
36 shrub
37 sir
38 slash
39 so
40 tack
41 teach
42 that
43 time
44 tinge
45 tweed
46 vile
47 weave
48 wed
49 wide
50 wreck

PB-50 List 16

1 aid
2 barge
3 book
4 cheese
5 cliff
6 closed
7 crews
8 dame
9 din
10 drape
11 droop
12 dub
13 fifth
14 fright
15 gab
16 gas
17 had
18 hash
19 hose
20 ink
21 kind
22 knee
23 lay
24 leash
25 louse
26 map
27 nap
28 next
29 part
30 pitch
31 pump
32 rock
33 rogue
34 rug
35 rye
36 sang
37 sheep
38 sheik
39 soar
40 stab
41 stress
42 suit
43 thou
44 three
45 thresh
46 tire
47 ton
48 tuck
49 turn
50 wield

PB-50 List 17

1 all
2 apt
3 bet
4 big
5 booth
6 brace
7 braid
8 buck
9 case
10 clew
11 crush

12 dart
13 dine
14 falls
15 feet
16 fell
17 fit
18 form
19 fresh
20 gum
21 hence
22 hood
23 if
24 last
25 ma
26 mist
27 myth
28 ox
29 paid
30 pare
31 past
32 pearl
33 peg
34 plow
35 press
36 rage
37 reach
38 ridge
39 roam
40 scratch
41 sell
42 ship
43 shock
44 stride
45 tube
46 vice
47 weep
48 weird
49 wine
50 you

PB-50 List 18

1 aims
2 art
3 axe
4 bale
5 bless
6 camp
7 cat
8 chaff
9 chain
10 chill
11 chip
12 claw
13 claws
14 crab
15 cub
16 debt
17 dice
18 dot
19 fade
20 fat
21 flare
22 fool
23 freeze
24 got
25 grab
26 gray
27 grew
28 gush
29 hide
30 his
31 hush
32 lime
33 lip
34 loud
35 lunge
36 lynch
37 note
38 ouch
39 rob
40 rose
41 sack
42 sash
43 share
44 sieve
45 thaw
46 thine
47 thorn
48 trod
49 waste
50 weed

PB-50 List 19

1 age
2 bark
3 bay
4 bough
5 buzz
6 cab
7 cage
8 calve (cav)
9 cant
10 chat
11 chose (chōz)
12 crude
13 cup
14 dough
15 drug
16 dune
17 ebb
18 fan
19 find
20 flank
21 fond

22 gin
23 god
24 gyp
25 hike
26 hut
27 lad
28 led
29 lose (lōōz)
30 lust
31 notch
32 on
33 paste
34 perch
35 raft
36 rote
37 rule
38 sat
39 shy
40 sill
41 slid
42 splash
43 steed
44 thief
45 throat
46 up
47 wheel
48 white
49 yes
50 yield

PB-50 List 20

1 ace
2 base
3 beard
4 brass
5 cart
6 click
7 clog
8 cork
9 crate
10 did
11 duke
12 eye
13 fair
14 fast
15 flash
16 gang
17 get
18 gob
19 hump
20 in
21 joke
22 judge
23 lid
24 mow (mō)
25 pack
26 pad
27 pew
28 puss
29 quip
30 ramp
31 retch
32 robe
33 roost
34 rouge
35 rout (rowt)
36 salve
37 seed
38 sigh
39 skid
40 slice
41 slush
42 soak
43 souse
44 theme
45 through
46 tilt
47 walk
48 wash
49 web
50 wise

AMERICAN BOARD OF OTOLARYNGOLOGY.

The American Board of Otolaryngology will conduct an examination in Chicago at the Palmer House, Oct. 4 to 9, 1948. For further information, write to Dr. Dean M. Lierle, Secretary-Treasurer, Iowa City, Iowa.

THE INJECTION TREATMENT OF ESOPHAGEAL VARICES DUE TO MANSON'S SCHISTOSOMIASIS. PRELIMINARY REPORT.*†

CARLOS E. MUNOZ-MACCORMICK, M.D.,
Santurce, Puerto Rico.

The encouraging results consistently obtained by a number of surgeons with the injection treatment of bleeding esophageal varices, as first done in this country by Moersch,[1] has enticed us to focus our attention on schistosomiasis, a parasitic disease that in its late stages closely resembles the so-called Banti syndrome, as pointed out by Bonelli[2] and Koppisch,[3] and which frequently kills by exsanguinating hemorrhages from esophageal varices. We shall deal exclusively with the Mansonic type of schistosomiasis, characterized etiologically by the lateral spine of its ovum (see Fig. 1), insofar as this is the only type of bilharziosis found in Puerto Rico, rather widespread over the Island, but with a much higher incidence in certain areas already mapped out as endemic zones by Faust, *et al.*,[4] Koppisch,[5] and Weller and Dammin.[6]

Dr. E. Koppisch has been kind enough to furnish us with the following brief summary of the pathogenesis of schistosomiasis:

"When victims of the disease defecate in streams, or nearby so that the schistosome ova reach the water, a free-swimming miracidium is hatched. This enters snails of the variety *Australorbis glabratus*, wherein metamorphosis and multiplication takes place, resulting in the liberation, after three or four weeks, of large numbers of cercariae.

"The disease is contracted by man while swimming or other-

*Presented as Candidate's Thesis to American Laryngological, Rhinological and Otological Society, Inc., 1948.

†From the University Hospital and School of Tropical Medicine, San Juan, Puerto Rico.

Editor's Note: This ms. received in Laryngoscope Office and accepted for publication, Feb. 20, 1948.

wise coming in contact with contaminated waters, the cercariae piercing the skin or mucous membranes, and passing into the lymphatics or venules of the derma. In this manner, whether directly from the derma, or indirectly through the lymphatics, they ultimately reach the right side of the heart, the parasites then continuing with the blood along the pulmo-

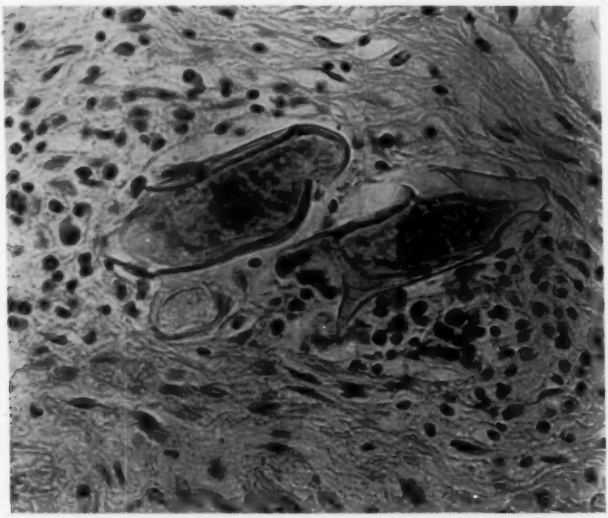

Fig. 1. Schistosome ova recently laid in submucosa of colon; note the contained embryo, the lateral spine in the ovum to the right, and the incipient infiltration with round cells and eosinophiles. 360×.

nary arterioles, and going to the left side of the heart. Their wandering is strictly intravascular and, therefore, determined by anatomical vascular relations. Thus, from the left ventricle the metacercariae (as the parasite is known from the moment it drops its tail and penetrates the host, until it matures into the adult worm) go to all of the tissues of the host. Many are lost by blocking blood vessels of a smaller diameter, producing perhaps a petechial hemorrhage, and being absorbed without further consequence to the host. If they manage to accomplish the circuit, they will again reach the lungs, and

probably be blocked there. Those that reach abdominal organs drained by the portal vein pass from the arterial to the venous side along the capillaries, and ultimately gain the intrahepatic portal branches, where they mature. At maturity, or shortly before, the male and female worms leave the liver and go against the portal blood current to their usual habitat. In Manson's schistosomiasis this is the hemorrhoidal venous plexuses, but in lesser numbers they are also found in colonic and

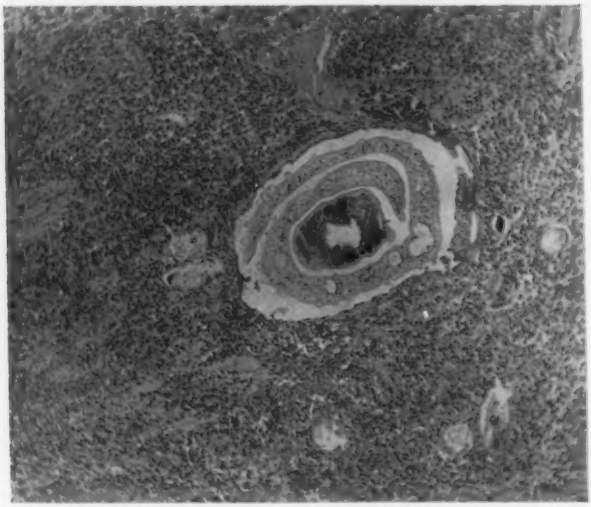

Fig. 2. Male and female worms in copula within vein of rectal polyp; note ova in surrounding tissues, and dense infiltration with round cells. 80×.

mesenteric veins, and at times, particularly in heavy infections, they may wander to pelvic plexuses other than the hemorrhoidal, or to spinal veins and to the lungs. The parasites usually copulate (see Fig. 2) in the larger extraintestinal venous branches, during which process the female worm lies in the male's gynecophoric canal as in a hammock. The worms then separate, the female going to smaller branches, which it fits snugly, in the wall of the colon, again in diminishing numbers from the rectum proximad. Most eggs are laid in

veins of the submucosa and basal portions of the mucosa (see Fig. 3). Some are retained *in situ* by an extension over them of the endothelial cells lining the blood vessels. Others are swept with the blood current to the liver. Still others manage

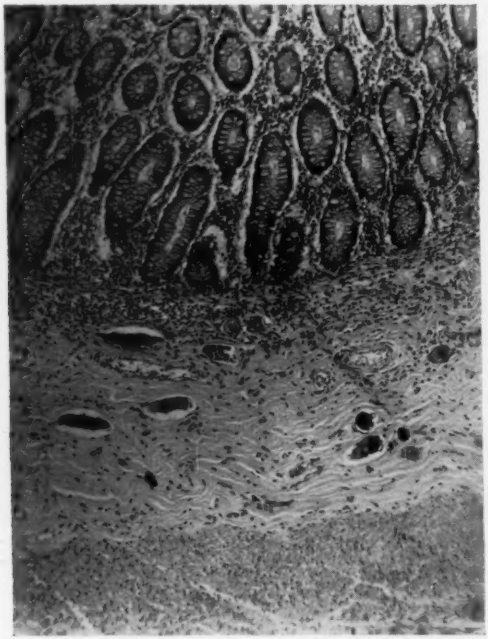

Fig. 3. Ova in submucosa of colon, some of them undergoing calcification. 80×.

to pass into the intestinal lumen and out with the feces, thus completing the life-cycle of the parasite.

"Sometimes the ova are carried to the lungs, probably along communications between the inferior hemorrhoidal veins and the inferior vena cava; or the worms may wander to unusual sites for oviposition, so that ova may be laid in the testes, ovaries, Fallopian tubes, uterus, urinary bladder and spinal

cord. Ova have also been found in the brain, kidneys, myocardium and skin. Bey Shaheen[6a] reported finding numerous ova in a fungating mass that developed in the larynx, above the level of the vocal cords, but although he gave no data on species identification most probably this was due to *S. haematobium*.

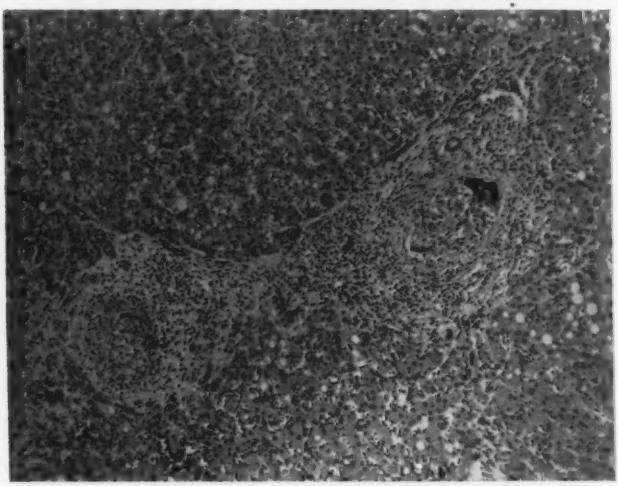

Fig. 4. Pseudotubercles about ova that have lodged in the portal spaces, accompanied by some fibrosis and infiltration with round cells and eosinophiles. 80×.

"The ova that are laid in the intestinal wall instigate a colitis. Those that are swept away by the blood do graver damage still, by accumulating in the portal spaces (see Fig. 4). The embryo soon dies and is absorbed, but the chitinous shell is very resistant, and its presence in the tissues instigates a fibrosis that after 10 years or longer, depending upon the heaviness of the infection, and upon the number of reinfections, produces the clinical syndrome of hepatic cirrhosis. Since the fibrosis in this organ is mainly portal, it causes intrahepatic blockage and gradually leads to portal hypertension with splenomegaly."

Nature attempts to establish anastomoses by means of which blood can pass from the overloaded portal system to the general systemic circulation. As pointed out by Moersch,[7] McIndoe[8] states that this may take place at three sites:

1. At the site of embryologic circulation — the falciform ligament with the paraumbilical vein.

2. At all situations within the abdomen where the gastrointestinal tract, its appendages or glands developing from it become retroperitoneal developmentally, or adherent to the abdominal wall, pathologically.

3. At the point of transition between absorbing and protecting epithelium.

a. Between the superior hemorrhoidal and the middle and inferior hemorrhoidal veins.

b. Between the coronary vein of the stomach and the intercostal, azygos and diaphragmatic veins. Since this is the shortest route between the portal and systemic circulations, anastomoses are more likely to develop here when there is portal hypertension (McIndoe); furthermore, there being no valves in the coronary veins, the increased pressure is transmitted to the periesophageal trunks through perforating branches of the larger trunks of the coronary plexus, and these, in turn, communicate with the azygos, intercostal and diaphragmatic veins of the systemic circulation. The fact that the veins in the submucosa of the lower part of the esophagus are poorly supported by loose connective tissue favors the formation of varices in this region (see Fig. 5).

Having thus covered the series of events that take place from the time of infection with the cercariae to the formation of the varices, a brief discussion of the diagnosis of schistosomiasis is indicated, before proceeding with a consideration of its treatment.

The diagnosis[9] is based on the following: *1.* A history of exposure to known contaminated waters in an endemic zone; *2.* a history of the disease, of which salient features are

periodic diarrhea, often bloody, bouts of fever and eosinophilia; *3.* progressive enlargement of the spleen and liver, later with contraction of the latter; *4.* a clinical picture of cirrhosis of the liver, or of Banti's syndrome; *5.* the search for eosinophilia, and for lateral-spined ova in the feces,

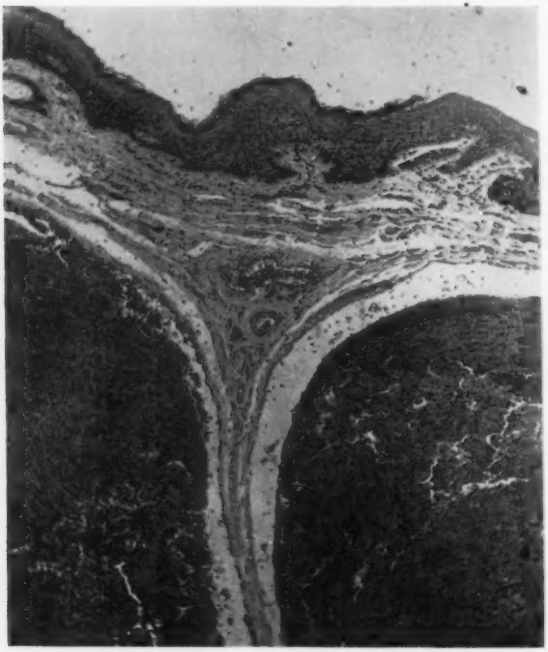

Fig. 5. Esophageal varices in case of advanced schistosomiasis that succumbed to hematemesis. 80×.

the latter preferably by methods of concentration, and, lastly, *6.* in certain cases, when still in doubt, by resort to special diagnostic procedures. Among the latter, the most important are biopsy of the rectal mucosa,[10] skin testing[11] with cercarial antigen, and exploratory laparotomy with biopsy of the liver.

Of all drugs used in the treatment of the disease, fuadin,

which contains 13.5 per cent of antimony, seems to be the one of choice. It is marketed as a clear isotonic solution containing 6.3 per cent of the drug, hence 1 cc. represents 8.5 mgm. of trivalent antimony. Fuadin is administered intramuscularly with very little discomfort. For an adult, the first three injections are usually given daily: 1.5 cc., 3.5 cc. and 5 cc., respectively. Subsequent doses of 5 cc. are given every other day, or every three days, until a total of 45 cc. has been given. Treatment can be repeated after a rest period of one to two weeks. For children, the initial dosage is 0.5 cc. If no reactions are produced, 0.5 cc. per 10 kg. of body weight is given on the second day, and thereafter 1 cc. per 10 kg. of body weight every two or three days until a total of 1 cc. per kg. of body weight has been administered. Hernández-Morales,[11] in an excellent presentation on the treatment of schistosomiasis, quotes the Research Institute of Egypt on stating that fuadin does not increase the hepatic damage of schistosomiasis when this is already present at the time of initiation of treatment. He states that the most common toxic reactions produced by the administration of fuadin are nausea, vomiting, epigastric pain, pain in the joints and loss of weight, and urges alertness in the early detection of toxic reactions since they may not only incapacitate the individual for a prolonged period of time, but also endanger his life. Excellent results, which compare favorably with those obtained with fuadin, have been observed lately by Hernández-Morales, *et al.*,[11a] with the use of antimony lithium thiomalate, commercially known as anthiomaline (Merck). Each cc. of this drug contains 10 mgm. of antimony. It is administered in 3 cc. doses every other day until a total of 45 cc. has been given. It is of paramount importance to institute treatment immediately after the diagnosis is definitely established.

The bleeding esophageal varices have been attacked from various angles, but all forms of treatment have proven to be rather discouraging. For the bleeding episode, general supportive measures, repeated transfusions and tamponage, either with the aid of the esophagoscope or through a gastrostomy opening. Direct pressure with a colpeurynter, as well as many

other measures, have also been advocated and tried. Operative procedures, such as the use of the thermocautery, electrocoagulation with the aid of the esophagoscope, or cauterization through a gastrostomy opening, have all been performed (Lund and Foley). Radical surgery has also been advocated. Henschen[13] believed that the logical procedure would be to ligate all the venous channels arising in the portal area and entering in the formation of the periesophageal and intraesophageal varicose plexuses, through a low intercostal thoracotomy on the left side, extended by an incision in the diaphragm into a transdiaphragmatic laparotomy. Splenectomy could be performed at the same time, if indicated, or when ligation of the splenic branches running to the esophagus were technically too difficult. If removal of the spleen were too hazardous, he would ligate the splenic artery, leaving the vein alone to remove the products of the breaking down of the organ. He points out, however, the numerous dangers and risks that may accompany this procedure.

Splenectomy has been generally advocated on the basis that it relieves the portal circulation of over 20 per cent of its load, that the amount of blood coursing through the esophageal varices is decreased by ligation and sectioning of the short gastric veins and the gastrolienal ligament, and that a new collateral circulation will be established at the site of denuded parietal peritoneum. Sometimes it is followed by an omentopexy with the Talma-Morison operation to further divert blood from the portal circulation through new anastomotic channels into the systemic circulation. In 1913, Mayo [14] advised splenectomy in splenic anemia, and reported 27 cases operated since 1905 with two operative mortalities. In 1929,[15] he reported 148 cases with 14 deaths, and stated that in about 10 per cent of the cases that recovered from splenectomy, death took place from hemorrhage within 10 years. Walters, Moersch and McKinnon[7] report 180 splenectomies performed at the Mayo Clinic in cases of splenic anemia from 1908 to 1935 with 10 per cent hospital mortality. Pemberton,[16] in a series of 98 cases, reported recurrence of esophageal bleeding in 50 per cent of them. More encouraging results are being

obtained lately, as Noya-Benitez[17] has reported a series of 23 cases with no hospital mortality. Follow-up demonstrated that all cases improved materially, as shown by blood counts, liver function tests and blood chemistry. He has had a recurrence of esophageal bleeding in only two, so far; however, it is obvious that splenectomy alone is not the answer to the problem.

Ligation of the coronary vein has also been done, as advocated by Rowntree, Walters and McIndoe.[18] Grace[19] reports a case of ligation and injection of 8 cc. of sodium morrhuate into the coronary vein with quite encouraging results.

Vascular surgery has been advocated (Blakemore[20]) in the form of lienorenal anastomoses, and of the portocaval shunt operation, similar to the well known Eck's fistula. It is so highly specialized a form of surgery and requires so many facilities available only in the largest hospitals and medical centers, that it certainly is not a practical solution of the problem of bleeding varices, and I doubt if it will ever be available to the great majority of these cases with any reasonable degree of safety.

The successful endoscopic injection of a sclerosing solution into the esophageal varices of a case of cirrhosis of the liver with repeated hematemesis by Moersch,[1] early in 1940, brought new hopes to the frightfully scared victims of these massive hemorrhages, and laid open a channel of approach which in view of the evidence now available might prove to be a very effective adjunct in the treatment of these desperate cases. Although Jackson, *et al.*,[21] had advocated, in 1914, the injection of horse serum directly into esophageal varices to arrest hemorrhage, and Moersch[1] and Pemberton suggested, in 1933, the possibility of injecting a sclerosing solution directly into the esophageal varices, it was not until Frenckner and Craaford, of Stockholm, reported, in 1939, a case treated successfully by the injection of quinine-uretan, that Moersch attempted such a procedure in this country. His efforts to produce esophageal varices in experimental animals had failed.

Soon after, Walters, Moersch and McKinnon[7] reported five additional cases of bleeding esophageal varices, treated by the

injection of 5 per cent sodium morrhuate with very encouraging results. Samson and Foree[22] reported, in 1942, a case of portal cirrhosis with ruptured esophageal varices treated successfully by the injection method and pointed out a few technical details which are, in my opinion, very valuable. Although their case died of an acute hepatic insufficiency a few months after the last treatment, it is obvious that the life of the patient was prolonged over one year by the intervention. Welt and Blatteis[23] reported, in 1944, a case of portal hypertension due to extrahepatic blockage, in which the bleeding esophageal varices were treated under very unfavorable conditions by the injection of sodium morrhuate directly into the bleeding varices; the procedure proved to be lifesaving.

CASE REPORT.

M. D. F., 33 years, white male, was admitted to the University Hospital of San Juan, Puerto Rico, on June 11, 1946, complaining of severe hematemesis. He had enjoyed fairly good health up to April, 1940, when he had an attack of pain in the right upper quadrant, radiating downwards and to the epigastrium, with vomiting. He was admitted to the Presbyterian Hospital of San Juan for study. Two renal stones were apparently the cause of the acute episode. The stools, however, were positive for schistosome ova, and there was eosinophilia of 5 per cent. Fuadin therapy was instituted, the patient receiving a course of four injections, six additional doses having been ordered after discharge from hospital, the treatment to be continued in the clinic. In April, 1944, he was again admitted to the Presbyterian Hospital, complaining of dizziness, nausea, fainting spells and pain in the lower abdomen. The spleen was now palpable four finger-breadths below the costal margin, and the liver was felt just below the costal border. The Hanger cephalin test was strongly positive; there was occult blood in the stools, and an eosinophilia of 11 per cent. Schistosome ova could not be found in spite of repeated examinations; however, in view of the eosinophilia and of the clinical picture presented by the patient, activity of the Bilharzial infection was blamed for the cause of his troubles, and a more intensive treatment was advised and instituted. He was given a course of 5 cc. injections of fuadin at three-day intervals. X-rays revealed esophageal varices. He left the hospital in May, 1944, and three months later received at the clinic another course of fuadin consisting of 5 cc. injections at three-day intervals for a total of 10 doses. Four months prior to admission he again felt below par, and registered at the Bilharzia Clinic of the University Hospital for treatment.

Two days before admission the patient suddenly felt dizzy and developed a severe frontal headache; his skin became cold and clammy, and he felt nauseated, vomiting shortly thereafter approximately 500 cc. of bright red blood. Four tarry stools were passed after admission.

His family history was interesting, since one brother had undergone splenectomy because of visceral schistosomiasis, one sister also suffered from the disease and died with ascites, another sister died of hemateme-

sis, and a third sister also underwent splenectomy for portal hypertension with splenomegaly, due to schistosomiasis.

Physical examination was irrelevant, except for an enlarged spleen palpable 5 cm. below the costal margin and a liver palpable two finger-breadths below the costal border. The stools were persistently negative for schistosome ova, and a rectal biopsy showed only one dead egg in two large samples. X-rays again showed esophageal varices.

His general condition was built up, and on July 12 splenectomy was performed under continuous spinal anesthesia. Biopsy of the liver was

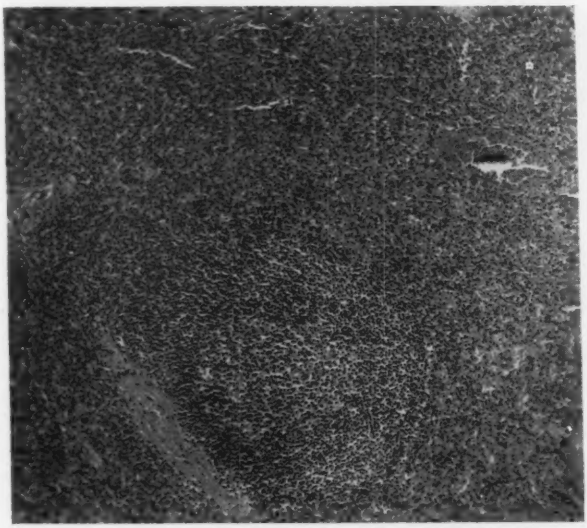

Fig. 6. Spleen of the present case showing that a diffuse fibrosis of the pulp had not yet developed, and that the lymphoid follicles are of normal size. 80×.

done at the same time (see Fig. 7) by Dr. Noya-Benítez, who stated in his operative report that "the liver was markedly cirrhotic."

Abstract of pathological examination of the spleen and biopsy of liver (Dr. E. Koppisch):

"*Gross:* The spleen was enlarged to 500 gm. The capsule was tense. On section, the pulp was firm and of bright red color, while the lymphoid follicles and trabeculae were of increased prominence. The portion of liver removed measured 1.5 x 1.3 x 1 cm. The external surface was yellowish and finely granular. The outer surface disclosed a greenish-yellow parenchyma.

"*Microscopic:* In the spleen the main alterations were thickening of the capsule by fibrosis and thickening of the reticulum, which in places

was more prominent about the malpighian follicles. The follicles were not smaller than normal (see Fig. 6). In the *liver* the portal spaces were thickened by fibrosis and were slightly infiltrated with lymphocytes (see Fig. 7). A single calcified schistosome ovum was found by sectioning serially (see Fig. 8). No pigment was present.

"*Diagnosis:* Splenomegaly, and fibrosis of portal spaces of liver, due to Manson's schistosomiasis."

On the fifth postoperative day the patient started to run a low-grade spiking fever which went up on the eighth day, when the patient com-

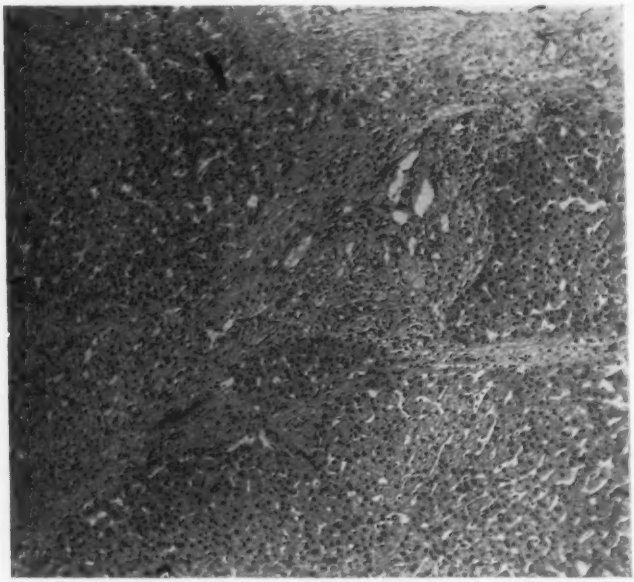

Fig. 7. Liver of present case showing fibrosis and slight infiltration with round cells. 80×.

plained of vague abdominal symptoms. A thrombosis of the splenic vein, or an early mesenteric thrombosis, were suspected and treated accordingly with heparin-dicumarol therapy, which was followed by a slow return to normal. He left the hospital on Aug. 21, feeling well.

Early in the morning of Dec. 7, he again felt dizzy and nauseated; he perspired profusely, and shortly thereafter vomited a large amount of coffee-ground material. He was readmitted that same day and had two tarry stools while in the hospital. He was gone over thoroughly and X-ray studies were repeated, confirming the previously established diagnosis of esophageal varices.

On Feb. 5, after his general condition had improved materially, the first esophagoscopy was performed under pentothal sodium. Many varices were found, extending from the hiatus up to a level 28.5 cm. from the upper incisors. A large varix, close to the hiatus, at six o'clock position, was selected for the first injection. It was pressed gently with the tip of the esophagoscope so as to enter it with the needle pretty nearly at a right angle, which was done, and after making certain of being in the vein by aspirating blood into the syringe, 2 cc. of 5 per cent sodium morrhuate were injected. A sponge carrier holding a piece of fibrin foam

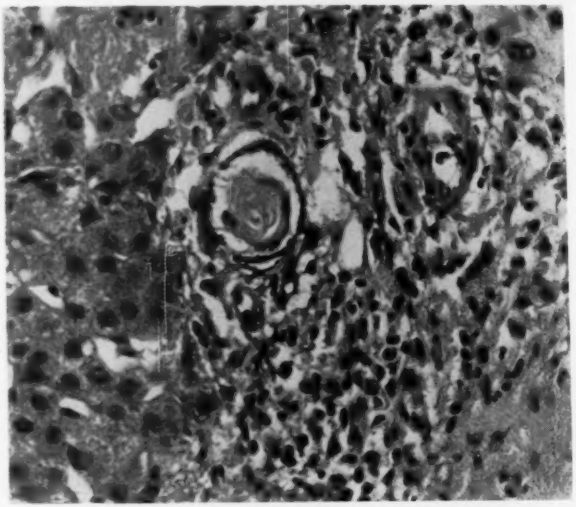

Fig. 8. Liver of the present case showing ovum with calcified shell. 360×.

was introduced to the level of the injected varix and pressed against the site of puncture. The tube was withdrawn approximately 2 cm., as recommended by Samson and Foree[22] and withdrawal of the needle was accomplished while pressure with the fibrin foam at the site of puncture was continued. There was practically no bleeding.

The second esophagoscopy was done under local pontocaine anesthesia on Feb. 12, at which time two varices, at a level of 40 cm. from the upper incisor teeth were injected with 1.5 cm. each, of 5 per cent sodium morrhuate, using the technique already described. One of the veins was at 12 o'clock position, which made injection decidedly more difficult than at the first intervention.

The varix injected at the previous session seemed harder and had receded materially, the esophageal lumen being now easily made out. It also looked a dark pink in color instead of bluish, as when injected.

A third esophagoscopy under local pontocaine anesthesia was per-

formed on Feb. 19. Two varices were selected, 36.5 cm. from the upper incisor teeth. Oxycel gauze was now used in the sponge instead of fibrin foam. It seemed to work satisfactorily, but was much harder to mold for a good grasp with the sponge carrier.

The fourth esophagoscopy, also under local anethesia, was performed on Feb. 26. One varix was selected, 28.5 cm. from the upper incisors, and injected with 1.5 cc. of sodium morrhuate. An attempt to inject at a lower level was unsuccessful; the varices were hard, and no blood could be aspirated after puncture.

The esophageal lumen was by now quite unobstructed, and the esophagoscope could pass very easily down to the hiatus. X-rays corroborated

Fig. 9. Irregularity of wall of esophagus suggesting varices.

the improvement, as determined by lessened tortuosity and prominence of the varices and a more normal aspect of the esophageal lumen.

The patient was discharged two days later, feeling well, and was followed up at the clinic until late in March, when he left for New York.

On May 5, he entered the Presbyterian Hospital because he had vomited clots of blood, which was followed by the passage of black stools. The course during hospitalization, as quoted from a report submitted to us by the Presbyterian Hospital, was as follows:

"On bed rest, evidence of bleeding subsided rapidly, and the stools guaic test, became negative. Proctoscopy was done, and a biopsy of the rectum was performed; no schistosomiasis mansoni ova were found. Dr. Blakemore was consulted, and was willing to do a portocaval shunt operation; however, it was felt that, in view of the normal liver chemistry, only one minor recent episode of bleeding, no other evidence of increased portal pressure and no ova in stools or biopsy, surgical intervention at this time was not indicated. Esophageal X-rays showed some irregularities, probably due to varices."

This report is very interesting, inasmuch as it shows restoration of liver function and complete eradication of the schistosomal infection, as demonstrated by the absence of ova from the stools and the negative rectal biopsy. Our finding of only one dead ovum in serial sections of the liver biopsy, with absence of schistosomal pigment, together with the fact that

Fig. 10. Tortuosity of esophageal mucosal folds and filling defects due to varices.

a single dead ovum was found at biopsy in two large samples taken from the rectum, had made us feel fairly certain that the disease was under control.

DISCUSSION.

This is clearly a case of advanced schistosomiasis with cirrhosis, or at least with marked portal fibrosis, splenomegaly and gastroesophageal varices. It was impossible to determine the age at which the infection was contracted, which almost certainly was in childhood. The first hematemesis supervened at the age of 33 years. The diagnosis was established by finding the ova of schistosoma mansoni in the stools; there also was eosinophilia of 5 to 11 per cent and, at the time of splenectomy, the surgeon found that the liver was distinctly cirrho-

tic. One brother and three sisters had suffered from undoubted schistosomiasis, which was the cause of death of two of them.

Treatment with fuadin was adequate, resulting in the disappearance of the ova from the stools, so that only a single dead ovum was found in a rectal biopsy done four years after the disease had been first discovered and treated. Further indications of the success of the treatment are to be found in the pathologic report on the biopsy of the liver and the removed spleen, in that only one partly calcified ovum was found in the liver, and no schistosomal pigment was seen in either the spleen or liver.

The patient had a copious hematemesis of 500 cc. on June 9, 1946, and again on Dec. 7 following. The gastroesophageal varices were injected endoscopically with sodium morrhuate on Feb. 5, 12, 19 and 26, 1947. On May 5, there was a recurrence of bleeding, producing subjective manifestations of hemorrhage, as well as tarry stools, but not hematemesis. For five months, as this note goes to press, there has been no additional evidence of bleeding.

The continued observation of this case, and of additional ones, will be necessary for evaluation of the real merits of the operation in the treatment of hematemesis due to rupture of gastroesophageal varices developing in the course of schistosomal cirrhosis of the liver. A few points, however, seem worthy of note: In the first place, it could be observed, at each subsequent esophagoscopic examination, that the varices were considerably reduced by the previous injections. This result, together with the cessation of bleeding, leads us to believe that the procedure may be lifesaving. If this were the case, it could then be of more than transient value in the treatment of advanced schistosomiasis. The operation must, of course, be preceded or accompanied by the intensive and appropriate treatment of the schistosomal infection. This is obvious from the fact that the varices are the result of damage done to the liver by the ova that are carried to that organ with the portal blood. The question of the extent to which the liver will regenerate, once it has been extensively damaged, cannot be answered at present. Koppisch[9] has expressed

his belief that after the onset of overt signs and symptoms of cirrhosis, eradication of the parasitism will not prevent the relentless advance of the hepatic condition. More recently, however, this author[24] has inclined to a more optimistic view, after seeing spontaneous *restitutio ad integrum* of experimental schistosomal cirrhosis in the rabbit, and learning of the favorable effects of a diet rich in proteins, carbohydrates and vitamins on idiopathic or Laënnec's cirrhosis in man.[25,26,27]

These posibilities open a new and more favorable outlook on the advanced stages of the disease. Since 25 per cent of the cases with advanced schistosomiasis succumb to the rupture of gastroesophageal varices, any measure that will prevent death from this horrible complication, thus giving time for the control of the parasitic infection, and for the institution of measures against the hepatic condition, might well prove to be of great value in the management of this disease.

SUMMARY.

Manson's schistosomiasis, a parasitic disease which in its advanced stage kills one out of four patients by exsanguinating hemorrhages from rupture of esophageal varices, is presented as meriting an ever increasing interest on the part of the endoscopist.

A brief review is made of the pathogenesis, diagnosis and treatment of schistosomiasis.

A case of esophageal varices due to schistosomiasis, with recurrence of bleeding after splenectomy, and treated by the injection of 5 per cent sodium morrhuate into the varices, according to the technique first described by Moersch, is reported. This is, as far as we know, the first case of bleeding varices in schistosomiasis treated by this method.

The treatment of bleeding esophageal varices due to intrahepatic blockage, with portal hypertension and splenomegaly, is reviewed. It seems proven that splenectomy alone, although the most reliable and time-honored surgical treatment for the condition, especially when combined with omentopexy, is not

the conclusive answer to the problem. Splenectomy, by relieving over 20 per cent of the load from the portal circulation, followed by the injection of a sclerosing solution into the varices at repeated intervals, might prove to be the treatment of choice, when and if splenectomy is indicated. Ligation and injection of the coronary veins have been tried with apparent success. Vascular surgery seems to be, as yet, too highly specialized a procedure to meet the demands of the vast majority of these cases, widely scattered as they are, throughout the endemic areas of the world.

The injection of a sclerosing solution directly into the esophageal varices, at intervals of a few days, until all apparent sources of bleeding have been sclerosed, does not seem to suffice unless repeated at intervals of several months. Recanalization or the formation of new varices may take place with recurrence of bleeding, requiring additional courses of injections which only through experience shall we be able to time; however, this form of treatment is of paramount importance insofar as it may be lifesaving; it can be repeated as necessary to maintain the patient free from bleeding. If by so doing, these victims of schistosomiasis can be kept alive until specific treatment for the disease is administered and the infection controlled, and while the internist, with a better understanding of liver function, enforcing a diet rich in carbohydrates, and proteins, low in fats and high in vitamin B, can restore the liver to normal functioning, we would be accomplishing a great task and proving that the endoscopist has a definite place, with specific responsibilities, in any well organized Bilharzial clinic.

Acknowledgment: We are indebted to Dr. E. Koppisch for all the microphotographs. Figs. 1 to 5, inclusive, belong to different cases of schistosomiasis, while the last three belong to the case herein reported.

BIBLIOGRAPHY.

1. Moersch, H. J.: Treatment of Esophageal Varices by Injection. *Proc. Staff, Mayo Clin.*, Mar. 20, 1940.

2. Bonelli, P.: Analogia entre la Schistosomiasis Mansoni y la En-

fermedad de Banti o Anemia esplénica. *Bol. Asoc. Med. de P. R.*, 23:251-258, 1931.

3. KOPPISCH, E.: Clinicopathological Analysis of Interesting Cases. *Bol. Asoc. Med. de P. R.*, 24:641-649, 1932.

4. FAUST, E. C.; HOFFMAN, W. A.; JONES, C. A., and JANER, J. L.: Studies of Schistosomiasis Mansoni in Puerto Rico. II. The Epidemiology and Geographical Distribution of Schistosomiasis Mansoni in Puerto Rico. 2. A Survey of Intestinal Parasites in Endemic Schistosomiasis Areas in Puerto Rico. *P. R. Jour. Pub. Health and Trop. Med.*, 9:447-471, 1933-1934.

5. KOPPISCH, E.: Studies on Schistomiasis Mansoni in Puerto Rico. VI. Morbid Anatomy of the Disease as Found in Puerto Rico. *P. R. Jour. Pub. Health and Trop. Med.*, 16:395-435, 1941.

6. WELLER, T. H., and DAMMIN, G. J.: The Incidence and Distribution of S. Mansoni and Other Helminths in Puerto Rico. *P. R. Jour. Pub. Health and Trop. Med.*, 21:125-147, 1945.

6. *a.* BEY SHAHEEN, H.: Bilharziasis of the Larynx — Case Report. *Arch. Otolaryngol.*, 35:286-287, 1942.

7. WALTERS, W.; MOERSCH, H. J., and MCKINNON, D. A.: Bleeding Esophageal Varices. *Arch. Surg.*, 41:1101-1117, 1940.

8. MCINDOE, A. H.: Vascular Lesions of Portal Cirrhosis. *Am. Jour. Med. Sci.*, 127:24-25, 1928.

9. KOPPISCH, E.: Manson's Schistosomiasis (Clinical Lecture at Atlantic City Session). *Jour. A. M. A.*, 121:936-942, Mar. 20, 1943.

10. HERNANDEZ-MORALES, F.; MALDONADO, J. F., and PRATT, C. KREISS: Diagnóstico de la esquistosomiasis de Manson por medio de la biopsia del recto. *Bol. Asoc. Med. de P. R.*, 38:253-259, 1946.

11. OLIVER-GONZALEZ, J., and PRATT, C. KREISS: Skin and Precipitin Reactions to Antigens from the Cercariae and Adults of S. Mansoni. *P. R. Jour. Pub. Health and Trop. Med.*, 20:357-362, 1945.

11. *a.* HERNANDEZ-MORALES F.; SUAREZ, R. M.; PRATT, CAROLINE K., and OLIVER-GONZALEZ, J.: Treatment of Schistosomiasis Mansoni with Anthiomaline. *P. R. Jour. Pub. Health and Trop. Med.*, 21:344-350, June, 1946.

12. HERNANDEZ-MORALES, F.: The Treatment of Schistosomiasis. *P. R. Jour. Pub. Health and Trop. Med.*, 20:322-338, 1945.

13. HENSCHEN, C.: *Arch. f. Klinische Chirurgie*, Berlin, 193:1-753, Sept. 21, 1938. Ab. *Jour. A. M. A.*, p. 2056, 1938.

14. MAYO, W. J.: Quoted by Moersch.[7]

15. MAYO, W. J.: The Enlarged Spleen. *Calif. and West. Med.*, 3:383-386, 1929.

16. PEMBERTON, J. DE J.: Results of Splenectomy in Splenic Anemia, Hemolytic Jaundice and Hemorrhagic Purpura. *Ann. Surg.*, 94:755-765, 1931.

17. NOYA-BENITEZ, J.: Splenectomy in Schistosomiasis—Preliminary Report. In press.

18. ROWNTREE, L. G.; WALTERS, W., and MCINDOE, A. H.: End-Result of Tying of the Coronary Vein for Prevention of Hemorrhage from Esophageal Varices. *Proc. Staff, Mayo Clin.*, 4:263-264, 1929.

19. GRACE, EDWIN J.: Control of Massive Esophageal Hemorrhage Secondary to Liver Damage (Cirrhosis) by Ligation of the Coronary Vein and Injection of Sodium Morrhuate. *Ann. Surg.*, 116:387-393, 1942.

20. BLAKEMORE, A. H.: Indications for Portocaval Anastomosis—Analysis of Cases. *Surg., Gynec. and Obst.*, 84:645-653, 1947.

21. Jackson, Tucker, Clerf, Lukens and Moore: Hematemesis. The Laryngoscope, 24:154, 1914.

22. Samson, P. C., and Forbe, L.: Direct Injection of Esophageal Varices Through the Esophagoscope. *West. Jour. Surg., Obst. and Gynec.*, 50:73-77, 1942.

23. Welt, B., and Blatteis, S. R.: Esophageal Varices—Case Report. *Am. Jour. Surg.*, 63:415-417, 1944.

24. Koppisch, E.: Personal communication.

25. Heming, R. G., and Snell, A. M.: Portal Cirrhosis with Ascitis: An Analysis of 200 Cases with Special Reference to Prognosis and Treatment. *Ann. Digest. Dis.*, 9:15, Apr., 1942.

26. Patek, A. J., Jr.: Treatment of Alcoholic Cirrhosis of the Liver with High Vitaminic Therapy. *Proc. Soc. Exp. Biol. and Med.*, 37:329, Nov., 1937.

27. Patek, A. J., Jr., and Post, J.: Treatment of Cirrhosis of the Liver by a Nutritious Diet and Supplements Rich in Vitamin B Complex. *Jour. Clin. Inves.*, 20:481, Sept., 1941.

INTERNATIONAL CONGRESS OF OTOLARYNGOLOGY, LONDON, 1949.

The British Association of Otolaryngologists is organizing the Fourth International Congress of Otolaryngology, to be held in London from July 17 to July 23, 1949. There will be further meetings, for those who wish to go, at Oxford, Cambridge and Edinburgh on July 25 and 26. It is hoped that a full academic program will be arranged, and also various social functions.

The secretaries of the National Otolaryngological Societies have been circularized and asked to send a list of their members for individual notification. Should any association not receive this letter, they should communicate with the General Secretary, F. C. W. Capps, F.R.C.S., 45, Lincoln's Inn Fields, London, W.C. 2.

VEGETAL BRONCHITIS. A SUMMATION OF THOUGHTS ON ITS ETIOLOGY. PRESENTATION OF TWENTY-THREE CASES.*

ELMER O'BRIEN, M.D.,
Rochester, N. Y.

In 1869, a pretentious volume of surgery presented a chapter on foreign bodies in the air passages. This textbook was written by Erichsen,[a] who evidently had a keen insight of this problem. Even at that time, he recognized a difference in reaction of various substances, but, like the host of writers that followed his age, he could not satisfactorily explain this mystifying phenomenon.

When a foreign body found its way into the lower respiratory tract, Erichsen described three stages of events. He called the first stage the "period of obstruction." His description showed that he was familiar with those primary acute symptoms of short duration so common in these accidents. Second, he surmised that obstruction was caused by impaction of the object in the larynx or trachea. If the intruder passed the glottis, he claimed that it often floated in the tracheal air currents and slapped against the undersurface of the vocal cords, causing irritation and wheezing. These were called the "symptoms of irritation." Third, the "symptoms of inflammation" occurred when the foreign body was allowed to remain in the lower air passages, usually terminating in the death of the patient from "marasmus or phthisis." This picture corresponds remarkably well with the clinical expositions of modern writers.

His treatment for this condition was rather conservative when compared with those of other contemporary authors.

---

*Presented as Candidate's Thesis to American Laryngological, Rhinological and Otological Society, Inc., 1948.

Editor's Note: This ms. received in Laryngoscope Office and accepted for publication, July 1, 1948.

"Emetics, sternutatories and succusion of the body" were described as not only useless but also extremely dangerous. He advocated an early tracheotomy and expectant treatment from that point on. Often when he opened the trachea, the foreign body was instantly coughed out through the wound. If this did not occur, he was discouraged and merely waited until it did happen — sometimes for several weeks. Instrumentation and even probing was discouraged. He cited 49 cases, 30 of which recovered.

Down through the ages, innumerable victims of inspirated foreign bodies were unrecorded and only in the last 50 years has this subject received its proper attention in the literature. A search of available writings on vegetable foreign bodies in the lower air passages proved to be very interesting and intriguing. The following compilation of the thoughts of various authorities is presented to show the tremendous strides in this field of surgery, mostly consummated after the age of bronchoscopy. This review will summarize the present knowledge of this particular subject with emphasis on the etiology of the characteristic intense reaction that accompanies this condition. To date, all authorities agree that such a reaction really occurs, but none of them satisfactorily agree upon its cause.

The initial endoscopic foreign body removal was accomplished by Killian in 1896. During that year, only five objects were reported as removed from the lower air passages, aided by the bronchoscope. The art of this maneuver was acquired by Killian's pupils and slowly reports began to be published by other enthusiasts. Bronchoscopy was born but was used only for extraction of foreign bodies at this period.

Bruning[2] published a textbook on endoscopy in 1912 and here can be found this startling statement: "Substances, however, like fresh fruit, especially when unripe, dried shell fruits and the pips of fruit with peel, often remain in the moist, warm recesses of the bronchial tree and resist decomposition so long that a serious affection of the lungs may

occur." Other than that, he had not observed the peculiar quality of a vegetal bronchitis.

A book on tracheobronchoscopy, written by Mann,[32] in 1914, divided the foreign bodies into two groups, but he could not tell why organic foreign bodies acted as they usually did. Wright and Smith[44] published a textbook in 1914, and for the first time I found some definite information on this subject. They stated: "Foreign bodies sometimes occasion great inflammatory disturbances in the bronchi themselves. It has been noted by a great many observers that peanut fragments present the most serious consequences of any inspired body. Whether this is due to the small size of the material entering some of the smaller bronchioles, or due to some peculiarly irritating substance within the peanut itself, is unknown."

During the following year, Jackson[16] published his book and here we find practically the same thoughts; however, he gave Dr. Ellen Patterson credit for that observation. Peanut foreign body cases offered so much trouble in his clinic at that time that he referred to them as his "peanut bronchitis" cases. Bruning[3] again published a book in 1915, in collaboration with Albrecht,[3] but he made no observation on this subject. Chiari's[4] book on the subject of foreign bodies appeared in 1916, but he also failed to throw light on the subject under perusal.

By this time, Jackson's[17] interest was aroused and in 1919 he published an article that showed great strides had been made in his clinic in the study of this problem. New facts hitherto overlooked were uncovered and helped to guide other observers. He observed that other vegetal foreign bodies created the identical clinical picture as seen in the peanut cases. The reaction in these cases is so diffuse, he discovered, that it would indicate etiological factors independent of obstruction. He mentioned peanut thresher's fever as an example and posed the question of its being due to the introduction of an alien protein parenterally.

Another paper appeared that same year, in which Jackson

urged his co-worker, Dr. W. M. L. Coplin, to solve the question. Dr. Coplin wondered if some chemical, irritating substance might exist in the peanut which might have been developed in the process of roasting. He asked the question, "Is it due to contact of an alien protein with tissues not naturally accustomed to such substances, and is it nature's unusually violent effort to split up and get rid of a complex alien protein by an unnatural route?" Evidently Dr. Coplin never found time to answer his own questions, for I could find nothing in the literature on the subject up to the time of his untimely death in 1928.

Dr. Ellen Patterson[35] reported six peanut cases in an article that appeared in 1919, but failed to inform us concerning her views on this subject.

Jackson[19] addressed the Roentgen Ray Society in 1920. Among his remarks, I discovered the statement, "Of all the organic foreign bodies in the bronchi, the peanut is the most frequent. As before pointed out, there seems to be some inherent, irritating quality in nut kernels which causes a diffuse, edematous, purulent inflammation throughout the lower air passages from the larynx to the finer bronchi." He offered no explanation.

A new edition of Jackson's[20] textbook appeared in 1922. At that time he mentioned the exaggerated symptoms that arise from peanut aspiration but did not go into further detail.

During the year 1924, Manges[31] published an article which contained an extensive description of Roentgenograms that one might find in peanut foreign body cases. In this article the term, "arachidic bronchitis" first appeared in print. He said, that up to that time, Jackson had studied 104 cases of peanut foreign body inhalations.

Also, in 1924, McCrae[33] delivered his beautiful, scholarly Lumbeian Lectures before the Royal College of Physicians. In his remarks, he spoke of arachidic bronchitis and said the cause of this intense irritation was not clear. He stated that peanuts contain two globulins, arachin and conarachin, and

possibly some other substances that might have a special irritating quality.

Late in 1924, Clerf[5] reported 50 cases of foreign bodies in the air and food passages, 11 of which were aspirated vegetal substances. He found that all of these organic substances gave reactions of varied intensities. In his summary I found this assertion, "Foreign bodies of vegetable origin, when aspirated into the air passages of young children, invariably set up an intensive laryngotracheobronchitis with a marked constitutional reaction. In older children and adults, this reaction is lacking and the pathology is usually limited to the obstructed bronchus."

In 1925, Tucker and Clerf[40] reported 52 cases of aspirated vegetal foreign bodies. Most of these cases evidently presented unusual problems. Later that year, Jackson, Tucker and Clerf[21] presented a paper on aspirated foreign bodies of organic origin. At this time the authors called this condition "vegetable bronchitis." Jacob Rosenbloom was given credit for suggesting the name "arachidic bronchitis" after the botanical name of the peanut, *arachis hypogaea*. The authors suggested the use of the term "vegetable bronchitis" except where a peanut kernel was aspirated. By this time, they had acquired statistics on about 200 cases of this type. They brought out the facts for the first time — the reaction severity is inversely in proportion to the age of the individual and directly in proportion to the length of sojourn of the vegetable foreign body. These two facts are now universally accepted. They believed then, as they do now, that all such cases have a fatal outcome unless the foreign body is removed either bronchoscopically or spontaneously. At that time, Dr. Iglauer was given credit for the first one to describe the Roentgenogram of atelectatic emphysema. He observed this characteristic shadow in 1911 but neglected to publish his finding.

At this time a new name appeared in the literature, a name that was destined to command attention. In 1926, we were introduced to the works of Vinson[41] in an article that appeared in the *Archives of Otolaryngology*. After describing a case of a two-year-old child, who coughed up a peanut after

its sojourn of one year, with excellent results, made these observations: "The aspiration of a peanut kernel usually causes a severe reaction of tracheal and bronchial mucosa, with edema and purulent exudate within 24 hours. The patient becomes acutely ill. Death may soon follow, unless the kernel is removed by bronchoscopy. Several observers, particularly Jackson, have called attention to this reaction and have attributed it to an intrinsic chemical irritant."

Shortly after this article appeared, Jackson[22] claimed that foreign bodies seem to have some inherent quality of building up a barrier in the tracheobronchial tree to resist pyogenic invasion. What this process is, he was at a loss to say, but suggested that it might be ionic, especially where metallic substances are concerned. With the exception of a vegetable foreign body, the suppuration quickly clears up when the foreign body is removed from the air passages. He thought that the reaction that accompanies foreign body invasion in the lungs is one of a hyperplastic damage to the pulmonary tissues, whereas other suppurating reactions cause a liquefaction. At this same time, Kernan[27] reported eight cases of aspirated peanut kernels, but offered no theories on the subject. One of his cases expelled the peanut 23 years after its inspiration. He admitted extensive damage to the involved lung, but, like the remainder of his cases, this patient lived in spite of his experience.

A new edition of Jackson's[23] textbook was published in 1927, in which he merely mentioned this condition and referred the reader to his article that appeared in the *Atlantic Journal*[21] during the year 1925. That article was written by Jackson, Tucker and Clerf[21] and was reviewed above when the articles issued during that year were discussed. During the year 1927, Gill[10] presented a paper that might be aptly described as picturesque. Among the cases that he reported, there were two children of the same age who had aspirated corn into their right main bronchi. Although the sojourn of the kernels was the same, one child had a severe reaction and the other had none. He was unable to explain this difference

and advanced the possibility of the destruction of the "toxic element" by the process of parching.

The work that probably stimulated more investigators than any other was reported in great detail in 1928 by Pinkerton.[36] Since the appearance of this study, investigators were offered a new avenue of approach. In the bibliographies of most articles that were to appear later, the name of Pinkerton occupied an enviable position when vegetable bronchitis was discussed. He injected various oils and fats into the trachea of rabbits and noted the resulting reactions. To date, there were no pathological specimens of lung tissues that had been subjected to organic substances. Systematically, he killed the animals at various times after the injection of the oil and made microscopic studies of the lung tissue. He observed that these tissues were usually invaded by numerous neutrophiles and large monocytes after exposure to oils of organic origin. The lumen of the air spaces was likewise filled with these cells. Some of the tissues showed numerous eosinophiles. Tissue that had been exposed to mineral oil showed numerous mononuclear phagocytes but no eosinophiles.

This work evidently enthused Heatly and Clausen,[12,13] for, in 1930, they presented two articles of ambitious proportions.

Guided by the findings of Pinkerton, they sought to explain the cause of arachidic bronchitis. When a foreign body case terminates fatally, it is such a shock to all parties concerned that even the thought of an autopsy is not to be considered. Following the death of some of these victims, an endoscopic examination has been tolerated by the relatives, but this procedure offered us little knowledge of the true pathology. Heatly was fortunate in this respect and was able to perform autopsies on some of his cases. Here we found the first descriptions of pathological findings in arachidic bronchitis.

Description of all lungs in arachidic bronchitis deaths showed practically the same changes. The surface of the involved lung appeared mottled with deep red areas of atelectasis interspersed with bleb-like areas of emphysema. The lymph nodes at the hilum were enlarged, red and softened.

When the lungs were sectioned, the purulent exudate sometimes filled the entire tracheobronchial tree. Mucosa was red, swollen and often ulcerated. Mucous membrane in many places appeared desquamated. Microscopically, the submucosa was intensely edematous; vessels engorged and tissues invaded by round cells. Alveolar septa were enormously thickened by edema and round cell infiltration. Many of the alveoli even contained purulent exudate.

Injecting rabbits as Pinkerton did, Heatly studied the results when peanut oil was used. He reminded us that peanuts contain oleic and linolic fatty acids in the free state. Typical reactions in the lungs were induced when peanut oil solutions were injected containing as little as 0.3 per cent free fatty acids. Bacteriological studies of these cases were negative. The fat-free residue, which consisted of unaltered proteins and carbohydrates, offered no reaction. He thought that there is a possibility of the production of free fatty acids in human lungs by hydrolysis when a peanut is present.

Heatly summarized his studies in the following statement, "In arachidic bronchitis, infection plays a part, but the primary rôle must be played by the free fatty acids present in the peanut." He had no faith in the foreign protein hypothesis because he felt the clinical picture to be highly atypical of such a reaction, and skin tests of peanuts were always negative.

Six peanut cases were reported by Gittins[11] in 1931. None of these cases showed any appreciable edema, although tw of these cases carried the nut in lungs for nine weeks. Among his 11 corn cases, there was marked reaction. At about this same time Stiles[39] presented 50 cases of foreign bodies of a vegetal nature, and he thought the primary cause of the bronchitis was some irritating chemical substance, but that infection and local trauma played at least a secondary part. Age was a big factor.

The whole subject seemed to lie dormant until 1933, when Schenck[38] reported his views on nonopaque bodies in the air passages. He thought uncooked dry beans were probably the

worst form of foreign body in the air passages because the warmth and moisture of the lungs caused great enlargement by swelling, and a violent laryngotracheobronchitis developed from some unknown quality of vegetal substances. Peanuts likewise exerted a most malign influence, and watermelon seeds were not much better — why, he did not venture to say.

Two cases of peanut inhalations were reported by Hill[14] in 1934, but this report was not accompanied by any comments on this particular problem. Concerning vegetal foreign bodies, Clerf[6] in 1935, found that peanuts offered little trouble in his experience — beans were always much worse. In 1940, he[7] reported his experience in 950 cases of foreign bodies in the air and food passages. He admitted more complications in vegetal foreign bodies that were aspirated, but advanced no explanation.

A new textbook, entirely devoted to the problems of foreign bodies was published by Chevalier and C. L. Jackson[24] in 1936. Here we have a comprehensive volume that clarifies many controversial statements of the past. Examination of this work causes one to marvel at their broad source of information, clear scientific logic and pleasant presentation. Here we are reminded that a peanut, botanically speaking, is not a nut. Chemically, it does not differ too much from a tree nut and its irritation in the air passages is no different. For this reason, they no longer differentiated peanuts in their case histories but listed them under nut kernels. In this book they listed in detail 565 vegetal foreign bodies in the air passages that came under their care. They found that dry beans caused more obstruction because of their shape and tendency to swell. They thought cooking and roasting vegetal substances did not alter the reaction.

We found pathological reports in Heatly's articles, but here we found the first intensive report of bronchoscopic pathology. They found in the usual case of aspirated vegetative foreign body that there was an early copious flooding of the parts. This was serous in nature primarily, but became thicker and mucoid in 24 hours. In 48 hours it became purulent. These early rapid changes appeared only in the presence of vegetal

foreign bodies. The intense inflammation was another characteristic of these foreign body cases. This exaggerated redness was quickly followed by a red edema. The bronchial rings became obliterated and the mucosa bled easily when touched. This reaction is so diffuse that it often includes the larynx and the other lung. The intensity and diffusion of the reaction is usually in inverse ratio to age of patient. The reaction usually clears up in a few days after removal of the foreign body, showing that its presence alone explained the phenomenon.

At the American Bronchoscopic Society meeting in 1938, Hill[15] revived this subject and thereby stimulated much discussion. He reported a case of a two-year-old child who aspirated a piece of celery and who presented the characteristic stormy clinical picture. When the celery was removed during bronchoscopy, intense inflammation was noted throughout the tracheobronchial tree. Tracheotomy as well as repeated bronchoscopic aspirations were required. After 84 hours, the child expired. Autopsy was refused. He had celery analyzed and this study revealed a fat content of only 0.1 per cent in a form unaffected by lung lipases (Pinkerton) and incapable of hydrolysis. He cited another instance in which a peanut had been removed after a sojourn of 38 days with a fatal termination. This case prompted him to wonder if the small pulmonary anatomy of babies or even the time element could be responsible, but he was at a total loss to explain the glottic and subglottic edema. The first discusser of this paper, Zinn, suggested that possibly cooked foreign bodies might be less irritating. Richards then stated that he had experience with 32 peanut cases and none of them showed the typical reaction. The time element varied greatly and only obstructive symptoms developed. Simpson surmised that raw vegetables, because they were usually not too clean, might be responsible. He also suggested that often these bodies are harbored in an already infected airway. The subject was then dropped, but one could see that the problem was far from a feasible solution. Evidently no one at that meeting had faith in any previously expostulated hypothesis.

During the following year (1939) two textbooks were offered the specialist interested in laryngology and allied subjects. Morrison's[34] book stated merely, "Vegetable foreign bodies such as nut kernels, peas, beans and seeds produce a violent vegetal bronchitis." Lederer[29] discussed the subject a little more extensively, but failed to enlighten us too much with this statement, "This (vegetal bronchitis) is apparently due to the irritating property of the highly unsaturated peanut oil."

"Foreign Bodies in the Lung" was written in 1941 by Jackson and Jackson,[25] but they offered nothing new at that time. During the following year, King[28] reported a case of multiple peanut fragments in both main bronchi. This occurred in a child of only 23 months of age and no unusual sequelae were noted, although the sojourn was of more than a month's duration.

Jackson and Jackson[26] published their latest textbook in 1945, and in it we find this subject dismissed with the statement, "The irritating qualities of vegetal substances are in some instances chemical, in others allergic." This seems like a statement with an air of finality and they refer the reader to their textbook[24] of foreign bodies, published in 1936.

An article by Rosedale,[37] in 1946, presents in detail subjective and objective findings in vegetal foreign bodies, but no attempt is made to explain their causes. In 1947, a practical text on ear, nose and throat diseases was offered by Wolf.[43] He quickly disposed of this subject by stating, "Vegetable organic substances such as peanuts, kernels, beans, watermelon seeds and the like may cause an immediate and violent laryngotracheobronchitis."

This brings us up to date on all available literature on vegetal bronchitis. I have presented it in chronological order to emphasize the evolutionary thoughts on this perplexing subject. It is clear that all modern authorities agree on the clinical picture of vegetal bronchitis and its treatment, but I am still convinced that they are in a quandary when its characteristic reaction is explained. I was deeply impressed with

this feeling by the discussion that followed Bonnier's[1] presentation at the 1947 session of the American Broncho-Esophagological Association. After he reviewed his experiences with 30 peanut cases, several speakers voiced their opinions in decidedly uncertain terms — apparently unmindful of the teachings of the Master, Jackson.

I believe it would be wise at this point to refer to Jackson's[24] textbook on "Diseases of the Air and Food Passages of Foreign Body Origin." Although this book was published in 1936, most of the literature that has appeared since that time shows a pitiful lack of knowledge of the contents of that volume. Here we can find the causes of vegetal bronchitis in a neat and concise tabulation. Evidently there is no single cause, but each case is controlled by one or more causes due to different circumstances.

The first cause that they discuss is the mechanical factor, which is important in any foreign body case. Some vegetal foreign bodies are hard and sharp; others produce a chafing effect as a result of their to-and-fro passive motion. Some of these bodies swell in their position to complicate matters.

The chemical action of vegetal foreign bodies rarely must be recognized. Occasionally they may contain material that is directly irritating to the pulmonary tissues.

A strange but powerful cause is termed the biochemical cause. Many organic substances may contain irritating elements developed by bacterial or tissue-cell activity. We are reminded by Jackson and Jackson that "the lungs are endowed with a powerful, natural defensive mechanism, biomechanical or biochemical, or both, against invasion of pyogenic organisms in the presence of all foreign bodies except vegetal."

The next cause that they discussed is the allergic theory. This factor has been overlooked by practically all investigators and is probably the most important one of all. Quoting from Jackson and Jackson we find, "Over 600 cases showed clearly this reaction is in inverse ratio as the age—an exactly contrary allergic effect of horse serum." In spite of this para-

dox, we cannot be unmindful of the strange tricks of allergy uncovered during the past 10 years. Many heretofore unexplained syndromes have been unmasked as various forms of allergy. Most of these have been proven only by their yielding to allergic therapy. Numerous vegetal foreign body cases have been mentioned in reports where all conditions were parallel, but the reactions varied tremendously. A patient allergic to the particular organic substance would be found to produce a great reaction. A person who fortunately is not allergic to the inhaled substance would suffer only from its mechanical influence. Pinkerton observed eosinophiles in some of the pulmonary tissues subjected to certain oil baths. This should prompt someone to attempt to demonstrate a preponderance of eosinophiles in cases of vegetal bronchitis of an exaggerated and unexplained reaction. In some of my personal cases, the reaction was diffuse and profound in a matter of hours, whereas other cases, in spite of the age of the patient and sojourn of the foreign body, seemed to suffer very little inconvenience. Allergy could easily explain this difference.

At one time it was a popular custom to treat nontuberculous pulmonary infections with instillations of iodized oil. Occasionally I encountered patients who would display reactions other than those seen in iodism. I overcame this difficulty by changing the brand of iodized oil because each company that dispensed these products used a different oil vehicle. I felt that the occasional patient who reacted to poppy seed oil or sesame oil was allergic to that particular substance. A change to peanut oil would always avoid the unpleasant occurrences that were encountered with the other products. Criep and Hampsen[8] reported in 1937 that they acquired from available literature 10 asthmatic cases that had severe reactions following the instillation of iodized oil, five of which were fatal. One case in particular, a 13-year-old girl who died 20 hours after lipiodol, showed only bronchial asthma at autopsy. Mahon[30] reported a fatality after the instillation of 20 cc. of lipiodol. There was no allergic history. Autopsy showed "emphysema of lungs. Bronchi filled with viscid, tenacious mucus. Microscopically, the bronchial plugs, mucosa and sub-

mucosa were infiltrated with eosinophiles and lymphocytes." He concluded that his patient died of a severe allergic reaction to the lipiodol — probably the iodine portion. His conclusion was later refuted by Waldbott,[42] who admitted the death was due to allergy, but cocaine was the offending allergen. This I consider immaterial, but I do contend that in certain individuals the lower air passages respond as allergic shock organs when invaded by a foreign organic substance, regardless of its form or size.

I herewith humbly present the highlights of 23 cases of vegetal bronchitis that came under my care. They are chronologically arranged and probably represent the usual trials and tribulations that accompany this type of work.

CASE REPORTS.

Case 1: J. H., aged six, who was eating salted peanuts, June 24, 1928. He was bending his head far back as he dropped the peanuts into his mouth. Suddenly he began to choke and gag. He immediately ran home, coughing severely. He related his experience to his parents, but after a short rest his cough disappeared and the parents felt that his troubles were over. This was followed, however, by occasional coughing attacks which were worse at night. Finally on July 6, 1928, he was brought to his family physician, who discovered coarse rales throughout both sides of the chest and a decided wheeze was heard. Temperature then was 102° F. On the following day, the chest signs were unchanged and he was admitted to the hospital. Roentgenogram showed no atelectasis or other evidence of a foreign body; in fact, it was entirely negative. After 24 hours' rest in the hospital, he became asymptomatic and the chest examination was quite normal. He was then discharged, but after a few days of activity his cough reappeared. He was readmitted to the hospital on July 14, 1928, and his chest revealed rales throughout both sides, with a distinct wheeze. The cough was apparently unproductive. Because of the suggestive history and persistent symptoms, he was then transferred to the bronchoscopic clinic for study.

Without benefit of another Roentgenogram, we immediately bronchoscoped him. Using no anesthesia, we introduced a 5 mm. Jackson scope. The left bronchus was functioning well, but the distal end of the right main bronchus was intensely red and swollen. Here we discovered a half kernel of a peanut and with a peanut forceps removed it without fragmentation. On the following day patient had a slight cough, but no wheezing could be heard. The temperature was 102° F. On the next day the temperature was normal and the cough very slight. He felt so well that he was discharged.

On July 28, 1928, he was readmitted to the hospital because of return of his cough. The temperature ranged between 99° F. and 100° F. Moist rales were heard over the right lower chest with some wheezing. Bronchoscopy then showed no pathology in left bronchus, but the mucosa

in right main bronchus was red and swollen. We treated this with 10 per cent silver nitrate.

On Aug. 25, 1928, another bronchoscopy was done when a tiny particle of peanut was discovered floating in the mucus of the right main bronchus. Because of persistent cough and rales in right lower chest, he was bronchoscoped again on Sept. 8, 1928. Mucosa of right main bronchus was still inflamed but no foreign body could be found. On Sept. 20, 1928, his physician reported that he was well clinically. Coughing began again one year later and on Dec. 14, 1929, Roentgenogram showed a mottling effect throughout both lungs, as one would find in bronchopneumonia or chronic bronchitis. On May 13, 1930, Roentgen ray again showed the mottling still existed, with right diaphragm now high. Chronic cough brought him back to the hospital on Sept. 24, 1937 (nine years after inspiration of peanut). Cough now was productive. The temperature was 102.6° F. and respirations 36. Roentgenogram revealed a massive collapse of right lung, with empyema. Rib resection failed to improve the situation and he expired on Oct. 14, 1937. Autopsy was refused.

Case 2: C. F., aged seven months, was playing on the floor as his mother was preparing some string beans. Suddenly patient started to choke. Mother put her finger in child's mouth and hooked out some pieces of string bean. Child's breathing continued to be embarrassed and noisy—mother rushed him to hospital where her fears were realized. On admission, there was an asthmatoid wheeze at the open mouth and rales over the right lower chest. Because of acute respiratory distress, bronchoscopy was done at once. A 4 mm. scope was inserted with difficulty through an edematous glottis. Bean substance was removed from right main bronchus. Mucosa intensely inflamed in this region. Careful aspiration failed to reveal any particles. Procedure was followed by dry cough. Temperature did not exceed 101.5° F. About 36 hours after the inhalation the child suddenly became dsypneic and restless. A tracheotomy was done, but in vain. Autopsy showed a huge thymus gland and an acute laryngotracheobronchitis. No foreign body was found.

Case 3: G. G., aged eight years, seized with a severe coughing spell 10 days before admission to hospital, while eating English walnuts. Acute distress continued for about five minutes, but since that time he had only an occasional cough that disturbed his parents. Examination showed a boy in no distress. The temperature was 101° F., pulse 90, respirations 30. Breath sounds and vocal fremitus diminished on right lower chest, posteriorly, with dullness in that area. Roentgenogram showed opacity throughout lower right chest with upper displacement of that diaphragm. Against advice of the hospital staff, his uncle signed a release and took patient home. That night he coughed severely and brought up some material that patient described as particles of a nut. He was brought back to the hospital the next day with a temperature of 104° F., pulse 101 and respirations 30. Bronchoscopy done at once with no anesthesia. No foreign body was discovered. Some pus detected in right main bronchus and here the mucosa was markedly injected. We cleared out the area by suction and applied 1:1000 solution of aqueous metaphen. Culture from the involved area showed a growth of diplococci. Temperature went to 104° F., but after 10 days of a stormy time he recovered enough to be discharged.

Case 4: A. J., aged three years, was made to laugh while eating salted peanuts with playmates. She suddenly had a choking spell, followed by severe coughing. The children ran to her mother and reported the incident. By this time the cough was slight and the mother waited. After

some time had elapsed, the mother became alarmed when she noticed the child's breathing continued to be rapid. She notified the family physician, who advised her to take the child at once to the hospital. On admission the temperature was 99.4° F., respirations 35. There was an occasional dry, croupy cough and patient seemed toxic. Rumbling sounds were heard over entire anterior chest, which were synchronous with peculiar vibrations felt on palpation. These were more marked on right chest and on inspiration. Roentgenograms failed to demonstrate the presence of a foreign body. Bronchoscopy was done at once because of the history. A 4 mm. scope was introduced with no anesthesia. A small, nonobstructive piece of peanut kernel was removed from the right main bronchus. Mucosa showed no unusual reaction. Temperature then ranged between 99.5° and 100.5° F. for next 48 hours and then remained normal until his discharge 14 days after inhaling the foreign body. Although the Roentgenogram was negative prior to bronchoscopy, a routine check-up three days later showed decreased radiability, extending downward from the right hilum. At that time the child was clinically better. Ten days after the bronchoscopy, this increased density was definitely lessened; the child offered no clinical signs and was discharged.

Case 5: R. D., aged five years, was quietly munching on a piece of peanut candy when his mother was suddenly aroused from her work by his severe coughing and choking. This disturbance continued for about 10 minutes while his mother suspended him by his ankles and vigorously slapped his back. This maneuver made him worse and he became "black in the face." He soon was quieted and put to bed. His mother watched him throughout the night and noted that his breathing was very noisy. The next day he was brought to the family physician because of the wheezing respirations and the frequent coughing bouts. Roentgenograms then revealed, on full inspiration and expiration, definite evidence of atelectasis of the right lung. Movement of right diaphragm diminished. The mediastinal structures were displaced to the right side. With this evidence the doctor advised immediate hospitalization, but this was delayed until the following day. On arrival at the hospital, there were coarse rales throughout both sides of chest. No asthmatoid wheeze could be detected, and the child was in no particular distress. Immediately a 5 mm. scope was introduced with no anesthesia. Although the right main bronchus was markedly injected and swollen, no foreign body was discovered in that structure. When the scope was placed into the left main bronchus, a quarter of a peanut kernel was discovered and removed with a straight, grasping mosquito forceps. Gomenol was applied to the mucosa of both main bronchi. Patient suffered no untoward effects and went home in 48 hours with a normal temperature and only an occasional cough. Letter from his physician one week later stated that chest signs were rapidly disappearing.

Case 6: A. D., aged 17 months, ate candy containing peanuts, when she began to cough and choke. This was followed by a quiescent period, but when the cough persisted for two days, the child was brought to a hospital. Here she was studied for 24 hours and was discharged because of insufficient evidence of a foreign body. After 12 hours more, the cough grew worse and she was brought to our clinic with a temperature of 103° F. and respirations 40. Child did not appear too acutely ill. There was marked diminution of breath sounds throughout the left chest, with some moist rales over this area. Roentgen ray showed area of opacity near left hilum with no displacement or limitation of motion of the diaphragm. With no anesthesia a 4 mm. scope was introduced and a half of a peanut kernel was discovered in the left main bronchus. Mucosa in its vicinity was inflamed and bathed in a mucosanguinous material. A

mosquito forceps removed the foreign body and the child seemed to suffer no untoward symptoms from the procedure. After 48 hours, the temperature ranged from 98° to 100.5° F. Few moist rales were heard in left chest. Three days after bronchoscopy Roentgenograms showed that the opacity in the region of the left hilum had disappeared. The child was discharged.

Case 7: G. S., aged 28 years, put a heaping teaspoonful of peanut butter in mouth and with tongue formed it into the shape of a ball. Attempt to swallow this mass caused gagging and coughing. A drink of water caused more distress in breathing and a burning pain developed in the region of the suprasternal notch. Vomiting failed to relieve him and he came to the hospital for relief. On admission he was in acute respiratory distress. Rales were heard over area of trachea. The temperature was 99° F., the respirations 28. The Roentgenogram was negative. Under cocaine anesthesia, a bronchoscopy was then done. No foreign body was discovered, but the trachea and main bronchi were intensely inflamed. Gomenol was applied after thorough aspiration. After 48 hours he was discharged, clinically cured.

Case 8: C. P., aged 16 months, was eating peanuts when he was struck on back by another child. He began to choke and develop difficulty in breathing. His condition gradually grew worse and 24 hours later he was brought to hospital. The temperature was 101° F. and the respirations 42. There was no cyanosis, although the breathing was labored. Inspiratory thrill over left chest. There was a slight dullness posteriorly over the right chest. Coarse wheeze was heard at the open mouth. The Roentgenogram showed an area of increased density in region of the right hilum. Bronchoscopy with no anesthesia was then done and a half peanut kernel was found impacted in the upper half of right main bronchus. A straight grasping forceps was used and peanut removed. Thorough aspiration of a great quantity of mucus was accomplished and the lungs flooded with oxygen and carbon monoxide. For three days child had a croupy cough; temperature was 102.3-103° F., and occasional cyanosis. Then Roentgenograms showed some clearing of opacity. Six days after inspiring peanut the temperature reached the normal level and remained there. A severe cough still persisted, but child seemed quite comfortable. Two months later a check-up with Roentgen ray revealed considerable diminution in density in region of right hilum. A short time after this examination the child, under general anesthesia, was circumcised with no difficulty.

Case 9: A. M., aged 15 months, became dyspneic and cyanotic while eating a carrot. The child was brought to the hospital immediately. He had had an upper respiratory infection during the preceding week. On admission the child was acutely ill and was coughing excessively. The temperature was 98.6° F. and the respirations 25. Wheezes were heard over entire chest, but no rales. Because of this history, a bronchoscopy was arranged as soon as possible. By this time, the child became cyanotic, with an inspiratory stridor. Oxygen was given until the scope was introduced. No edema of the larynx or trachea could be demonstrated. A soft, moving foreign body was seen against the carina and quickly removed. Another particle was discovered in the right main bronchus and removed. Following this procedure, the color of the skin improved; breathing, although noisy, was not labored. For 48 hours, temperature ranged between 99° F. and 101° F. Five days later wheezes could still be heard over both lungs, but the child seemed comfortable and showed no fever. On the sixth day, the child seemed clinically cured and father demanded his release from the hospital and we acceded to his desires.

Case 10: W. F., aged four years, admitted to the hospital because of a brassy-like cough of three weeks' duration. It was impossible to get a satisfactory history. The respirations were labored and the temperature 103.2° F. Percussion notes were impaired in right upper chest. Loud rales were heard over both sides of chest. Roentgenogram showed no direct or indirect evidence of a foreign body. In spite of this report we deemed a diagnostic bronchoscopy was necessary to rule out a foreign body. No anesthesia was used and a 5 mm. scope was introduced. The right main bronchus was markedly congested and bathed in purulent material. After this was aspirated, a half peanut kernel was seen in the distal end of this bronchus. Removed peanut with a straight, grasping mosquito forceps without crushing. This was followed by immediate general improvement of patient. Next day the temperature reached 103° F. and rales were heard over the left lung. Roentgenograms showed, however, patchy opacities in region of right hilum—interpreted as pneumonia. In spite of this, the child was better the following day with a normal temperature, and continued to improve. Before we had an opportunity to discharge him, he developed measles and then mumps. A Roentgenographic check-up three months later showed marked improvement in lung markings.

Case 11: F. P., aged 16 months, just recovered from measles, when he suddenly began to cough and choke while eating peanuts. Although the choking soon stopped, a constant wheezing developed. He was brought to the hospital for investigation. Chest showed symmetrical resonance and no rales. Because of the history, no Roentgenogram was made and he was immediately bronchoscoped. A 4 mm. scope was used, with no anesthesia. An eighth of a peanut kernel was discovered in the distal end of the right main bronchus and removed with a mosquito forceps. Both main bronchi were then examined and aspirated. For three days the patient remained hoarse, with slight difficulty on inspiration. Temperature went as high as 102° F. Few rhonchi were heard over right lung. Six days after his admission, although he was slightly hoarse, his lungs were clear. Temperature was normal, so patient was discharged.

Case 12: D. B., aged 19 months, was eating peanuts when his father picked him up to put him in bed. During the ensuing struggle the child began to cough violently and became dyspneic. A physician was called and he ordered the parents to remove the child to the hospital. Upon arrival in the hospital his temperature was 101.5° F. with labored, rapid respirations. Cyanosis was pronounced and asthmatoid wheeze was distinctly heard. The Roentgenogram showed a generalized increased opacity, with pulmonary congestion or incomplete atelectasis. The heart was slightly displaced to the right. By this time the child was in desperate straits and semiconscious. No anesthesia was necessary and a 4 mm. bronchoscope was used hurriedly and a portion of a peanut kernel was found impacted in the distal end of the left main bronchus. The peanut was removed with a forward grasping forceps easily, but when the scope was removed the child immediately went into respiratory collapse. Stimulants and artificial respirations quickly revived the patient. The following day he was playful, although respirations were noisy. Three days later the Roentgenogram showed some opacity in lower left lobe. Temperature was normal. Rhonchi heard throughout both sides of chest and a slight cough persisted. On the seventh day he was well enough to be discharged.

Case 13: F. B., aged 11 years, came to the hospital four days after he "swallowed a peanut the wrong way." Peanut was in a chocolate bar. Patient complained of a pain in the left chest on deep inspiration. Twenty-four hours preceding admission to the hospital he developed a fever

and cough. Examination at this time showed decreased excursion of left upper chest with suggestion of dullness. The voice sounds were increased and breath sounds were diminished over that area. The temperature was 101.2° F. and respirations 20. Roentgenograms demonstrated extensive increased density over the upper half of left chest with displacement of mediastinum to the left and elevation of the left leaf of diaphragm. Blood count showed 12,800 leucocytes, with 6 per cent eosinophiles. On the following day, using no anesthetic, bronchoscopy was done. The left bronchus was bathed in thick mucus and the mucosa was decidedly inflamed. This was thoroughly aspirated and an extensive search was made for a foreign body, but in vain. For 48 hours patient showed steady improvement clinically, but there still remained an area as large as a half dollar on the left side, where the sternum forms an angle with the clavicle, that sounded dull with increased whisper. Mediastinum was still displaced to the left. This is my first case in which the sulfonamides were used. Sulfathiazole was tried for four days with apparent success, and this was even verified in the Roentgenograms at this time. Seven days after bronchoscopy he was so much improved that we allowed him to go home. Here his cough returned and it became productive. The temperature remained normal and he felt well. After a week at home, he was readmitted for further study. Dullness and diminished breath sounds were noted over the left upper chest anteriorly. Roentgenogram showed considerable atelectasis of the left upper lobe. Three days later another bronchoscopy was advised. This was done under local anesthesia (pontocaine 1 per cent). A 6 mm. scope was used and again no foreign body was found. A slight amount of mucopurulent material was seen and removed. All branches of the left main bronchus were examined and found to be patulous. The upper lobe bronchial mucosa was only slightly inflamed. This was followed by apparent improvement in all respects, and in one week he was transferred to a convalescent hospital. Two and one-half months after the onset of his illness he had a severe coughing spell and expelled half a peanut kernel. He then rapidly improved. Six years later he was admitted to the same hospital, suffering from acute appendicitis. At that time his lungs were clear to percussion and auscultation. Breath sounds were normal. No Roentgenogram was made. A general anesthesia was administered with no complications.

Case 14: G. O., aged 27 months, was brought to hospital because of great respiratory distress, 12 hours after eating peanuts. Upon admission the temperature was 104.8° F. and respirations 50. The chest showed slightly more movement on the right. The breath sounds were diminished throughout the left side of chest. No evident mediastinal shift. Because of the acute respiratory distress, a bronchoscopy was immediately done. Used a 5 mm. scope and no anesthetic. Scope encountered some obstruction in glottis and considerable pus was encountered in trachea. A quarter of a peanut kernel was impacted in the distal end of the left main bronchus, with great inflammation of mucosa at this site. This was followed by slight hoarseness and in 48 hours temperature reached the normal level. At this time there were many rales heard on the left side. Culture made from bronchi showed a growth of staphylococcus aureus. Sulfadiazine was then ordered. Nine days after admission child was discharged and chest was clear throughout. One year later this child was admitted to the same hospital for a popliteal abscess. During her stay in hospital, the lungs were examined on different occasions and were free of any pathology.

Case 15: H. S., aged 11 years, was brought to hospital after choking and wheezing while eating corn (maize). The temperature was 100° F. and

respirations 20. There was no cyanosis. Coarse rales were heard throughout right chest and diminished breath sounds over the right upper chest. Because of positive history, bronchoscopy was not delayed. A kernel of corn was discovered in distal end of right main bronchus and removed. In this area the mucosa was inflamed and bled easily, but there was no pus. Although there were a few scattered rales in right chest, the child was discharged within 24 hours.

Case 16: B. S., aged three years, admitted to the hospital because he had frequent attacks of upper respiratory infections, characterized by fever, cough, increased respirations, generalized bilateral rales and no response to supportive or sulfonamide therapy. Onset three months prior to admission. Two days before admission a Roentgenogram revealed an atelectasis on right side. The history was then reviewed and after much effort the fact was brought out that this might have started when the child was given peanuts. On admission to hospital, the patient did not appear too ill. Many scattered rales were detected over right, posterior chest. There was no area of consolidation, and the left lung was emphysematous. The heart seemed to be slightly displaced toward right side. Temperature and respirations were normal. Bronchoscopy was then done, using no anesthetic. Trachea contained much purulent material. Considerable coughing was induced by instrumentation and as fast as pus welled up, it was aspirated. Thorough search of right main bronchus was made with no success, but here the mucosa was intensely inflamed. After assuring myself that no foreign body existed there, I proceeded to investigate the main left bronchus. I was amazed to see a hard, light brown object moving to and fro in the lumen of this structure. A peanut forceps readily removed it and it proved to be half a peanut kernel. Evidently the vigorous cough and excessive flow of pus had dislodged it from the right bronchus and it settled down into the left bronchus while I was clearing out the trachea. In 48 hours he was discharged as the physical examination was negative.

Case 17: W. J., aged two years, began choking and coughing while eating peanuts. Patient brought to the hospital at once because the coughing grew worse. When he arrived at hospital his temperature was 97.4° F., although he had an upper respiratory infection during the past week. His pharynx was bathed by mucopurulent material trickling down from nasopharynx. Breath sounds alternately heard and absent in right chest. Many harsh rhonchi with few rales in right chest. There were 10,700 leucocytes with 1 per cent eosinophiles . Bronchoscopy was done as soon as possible, using a 5 mm. scope and no anesthetic. Half a peanut kernel was discovered in trachea at the carina. Structures were bathed in a great amount of mucopurulent material. The peanut was removed with peanut forceps. Temperature went as high as 101.6° F., but in 48 hours it became normal and remained there during the stay in hospital. The bronchoscopy was followed by a harsh, dry cough which disappeared after two days. After 10 days in hospital, Roentgen ray examination and physical examination of chest were negative. Patient discharged.

Case 18: G. D., aged one year, developed a cough and choking spell while eating peanut candy. After a persistent cough for four days, he was brought to hospital for relief. No cyanosis, but there was a persistent wheeze heard at open mouth. Moist fine rales at base of right lung. Roentgenograms showed no evidence of a foreign body—only some opacity in region of both hilums. The following day another Roentgen ray examination was made and this showed a mediastinal shift to the left. Clinician then suspected a foreign body in left main bronchus and advised its removal. Using no anesthesia, a 5 mm. Jackson scope was introduced

and the left main bronchus was found to be normal in appearance and free of a foreign body. The right main bronchus was intensely swollen and completely obstructed distally by a peanut fragment. This was removed and a thorough search revealed no further pieces. Then followed a few days of anxiety, a croupy cough, temperature of 101.5° F. and fine rhonchi over right lung. There was a gradual subsidence of these troubles and nine days after bronchoscopy he was discharged. On that day the Roentgen ray examination revealed residual density in right cardiohepatic angle.

Case 19: P. M., aged two years, developed a cough and sore throat. Pneumonia was diagnosed and treated with sulfadiazine. The child quickly responded to treatment and seemed perfectly well for about 10 days. She again developed a fever and started to have bouts of paroxysmal coughing. The child was then hospitalized with a temperature of 102.4° F. Percussion revealed a marked dullness at right base and empyema in this region was suspected. Sulfadiazine gave no relief and penicillin was no better. Leucocytes were 17,000 with 75 per cent neutrophiles. Roentgenogram showed an area of increased density at right base, which resembled atelectasis. One month after the onset the leucocyte count mounted to 38,200 and an exploratory thoracotomy was done, but no pus could be located. A few days later the roentgenologist found the same picture as previously described and he was the first to suggest the presence of a foreign body. I was then advised about his decision and on the thirty-third day of this patient's illness, a bronchoscopy was done under ether inhalation. Half of a peanut kernel was impacted in the right main bronchus and was removed intact. Scope was reinserted and a thorough aspiration done of the right lung, because the kernel released a great amount of purulent material. Prograss was rapid after this procedure and in 10 days he was discharged. Five months later a Roentgenogram showed nothing abnormal in the lung markings.

Case 20: W. C., aged nine years, developed a productive cough and a fever that often reached 104° F. Rest and supportive treatment relieved the situation in two days. Following the cessation of therapy, he had frequent bouts of coughing and elevation of temperature, and after two weeks he was admitted to hospital. By this time he was acutely ill with a temperature of 104° F. and respirations 26, but no cyanosis. Some dullness over lower right chest with diminished breath sounds and numerous sticky rales. Scattered rhonchi bilaterally. The following day Roentgenogram revealed a shadow in lower half of right lung, which probably represented a massive pneumonic consolidation. At this time he responded well under sulfonamide therapy, although the productive cough persisted. On the sixth day of hospitalization the roentgenologist suggested the presence of fluid in right chest. Thoracentesis was then done and 2cc. of a thick purulent material was aspirated. This fluid showed no growth on culture after 48 hours. After 10 days in the hospital, the Roentgenogram showed consolidation of right lower lobe, elevation of that diaphragm and mediastinal shift to right. His physician then for the first time thought of the possibility of a foreign body, and further questioning brought out the fact that five weeks ago the boy was frightened while eating peanuts. Bronchoscopy was then done, using a 5 mm. scope and no anesthesia. Half of a peanut kernel was found in distal end of right main bronchus, surrounded by a collection of pus. Mucosa badly injected. The peanut was grasped with peanut forceps and removed without fragmentation. Pus showed a culture of streptococcus viridans and staphylococcus albus. Nine days later a bronchoscopy again performed for inspection and aspiration. This was repeated seven days

later and very little pus was encountered. On this date Roentgenogram showed marked clearing of process in right lower lobe. Child discharged after one month in hospital and after six weeks of illness.

Case 21: K. C., aged two years, admitted to hospital in acute respiratory distress of a few hours' duration. Child was unconscious when brought to hospital. Temperature was 104.4° F., with respirations rapid (64) and shallow. Skin pale. Nuerological signs were essentially negative. Coarse sonorous rales heard bilaterally. Patient's brother is asthmatic. Roentgenogram done at once and showed nothing of interest in the lung fields. Pediatrician found breath sounds distant in right chest and many coarse rales. Resonance was impaired and almost flat in character. He suspected a foreign body, although the history failed to reveal this probability. Penicillin, 50,000 units; immediately given. Blood count showed 18,000 leucocytes. Patient improved under rest and penicillin, but continued to wheeze. A diagnostic bronchoscopy was decided upon six days after admission and this was done with no anesthesia. Used a 4 mm. scope and when right main bronchus was entered half a peanut kernel was discovered in a mass of purulent material. After its removal, the child's wheezing ceased and there was steady improvement. Eight days later, chest was clear to auscultation and percussion. Roentgenogram entirely negative and the patient was discharged.

Case 22: J. T., aged three years, started to choke while eating peanuts, 10 days before admission to hospital. There were frequent periods of cyanosis and wheezing. Examination on arrival showed lungs to be resonant. High pitched rales were heard on both sides of chest — worse on left chest. Wheeze heard at open mouth. Temperature 99.2° F. Complained of pain in left anterior chest. Roentgenogram showed some density in left lung field and mediastinal displacement to left. Three days after admission to hospital, I was asked to do a bronchoscopy. This was done under ether anesthesia and a 5 mm. scope was used. A portion of a peanut kernel was removed from the left main bronchus. Local reaction was not too evident. Convalescence was uneventful and 48 hours after bronchoscopy he was discharged.

Case 23: S. S., aged 14 months, was rushed to hospital six hours after choking on some fresh peas. Examination showed an acutely ill boy with wheezy respirations. Temperature 98° and respirations 24. Breath sounds were coarse over entire chest, with wheezing heard over right chest. There was no apparent shift of the mediastinum. Because of the history and physical findings, a bronchoscopy was done at once with no anesthesia. Using a 4 mm. scope, a quarter of a pea kernel was removed from the right main bronchus. Reaction was pronounced throughout the tracheobronchial structures and he was treated with penicillin and sulfadiazine. In 24 hours the temperature was 103.8° F. in spite of this therapy. In 48 hours a tracheotomy was necessary because of respiratory embarrassment, although there was no cyanosis. A week later he was decannulized and the following day discharged.

BIBLIOGRAPHY.

1. Bonnier, M.: Forty-five Cases of Peanuts Removed from the Lower Respiratory Passages. *Ann. Otol., Rhinol. and Laryngol.*, 56:784-789, 1947.

2. Bruning, W.: Direct Laryngoscopoy, Bronchoscopy and Oesophagoscopy. New York: William Wood and Co., 1912, pp. 301-324.

3. Bruning, W., and Albrecht, W.: Direkte Endoskopie der Luft und Speisewege. Stuttgart: Ferdinand Enke, 1915, pp. 182-185.

4. CHIARI, O.: Chirurgie des Kehlkopfes und der Luftdohre. Stuttgart: Ferdinand Enke, 1916, pp. 239-246.

5. CLERF, L. H.: Foreign Bodies in the Air and Food Passages. THE LARYNGOSCOPE, 34:784-810, 1924.

6. CLERF, L. H.: Foreign Bodies in the Air Passages. *Ann. Otol., Rhinol. and Laryngol.*, 44:879-888, 1935.

7. CLERF, L. H.: Foreign Bodies in the Air and Food Passages. *Surg., Gynec. and Obst.*, 70:328-339, 1940.

8. CRIEP, L. H., and HAMPSEY, J. W.: Therapeutic Value of Iodized Oil in Bronchial Asthma. *Jour. Allergy*, 9:23, 1937.

9. ERICHSEN, J. E.: The Science and Art of Surgery. Philadelphia: Henry C. Lea, 1869, pp. 385-389.

10. GILL, E. G.: Case Reports: One Opaque and Two Nonopaque Foreign Bodies in the Right Main Bronchus. *Trans. Am. Bronchoscopic Soc.*, pp. 180-184, 1927.

11. GITTINS, T. R.: Foreign Bodies in Air and Food Passages. *Ann. Otol., Rhinol. and Laryngol.*, 40:183-197, 1931.

12. HEATLY, C. A., and CLAUSEN, S. W.: Experimental Studies in Peanut Bronchitis. *Arch. Otolarynogl.*, 11:569-579, 1930.

13. HEATLY, C. A.: Peanut Bronchitis. *N. Y. State Med. Jour.*, 30:986-987, 1930.

14. HILL, F. T.: Peanuts, Needles and Saw-Horses. THE LARYNGOSCOPE, 44:327-333, 1934.

15. HILL, F. T.: A Consideration of Some of the Causative Factors of Vegetal Bronchitis. *Trans. Am. Bronchoscopic Soc*, St. Louis: Annals Pub. Co., 1938, pp. 90-100.

16. JACKSON, C.: Peroral Endoscopy and Laryngeal Surgery. St. Louis: THE LARYNGOSCOPE Co., 1915, p. 238.

17. JACKSON, C., and SPENCER, W. H.: Peanut Bronchitis. *Jour. A. M. A.*, 73:672-678, 1919.

18. JACKSON, C.: Foreign Bodies in Air and Food Passages. *Surg., Gynec. and Obst.*, 28:201-261, 1919.

19. JACKSON, C.; SPENCER, W. H., and MANGES, W. F.: The Diagnosis and Localization of Nonopaque Foreign Bodies in the Bronchi. *Trans. Roentgen Ray Soc.*, Jan., 1920.

20. JACKSON, C.: Bronchoscopy and Esophagoscopy. Philadelphia and London: 1922, pp. 129 and 227.

21. JACKSON, C.; TUCKER, G., and CLERF, L.: Arachidic and Other Forms of Vegetable Bronchitis. *Atl. Med. Jour.*, pp. 506-508, 1925.

22. JACKSON, C.: Suppurative Diseases of the Lung Due to Inspirated Foreign Bodies Contrasted with Those of Other Etiology. *Surg., Gynec. and Obst.*, 42:308-317, 1926.

23. JACKSON, C.: Bronchoscopy and Esophagoscopy. Philadelphia and London: W. B. Saunders Co., 1927, p. 153.

24. JACKSON, C., and JACKSON, C. L.: Diseases of the Air and Food Passages of Foreign Body Origin. Philadelphia and London: W. B. Saunders Co., 1936, pp. 104-112.

25. JACKSON, C., and JACKSON, C. L.: Foreign Bodies in the Lung. *Am. Jour. Surg.*, Vol. 54, Oct., 1941.

26. JACKSON, C., and JACKSON, C. L.: Diseases of the Nose, Throat and Ear. Philadelphia and London: W. B. Saunders Co., 1945, p. 740.

27. KERNAN, J. D.: The Reaction of the Lung to the Aspirated Peanut. THE LARYNGOSCOPE, 36:823-826, 1926.

28. KING, E.: Foreign Bodies — Case Reports. *Cinn. Jour. Med.*, 23:190-192, 1942.

29. LEDERER, F. L.: Diseases of the Ear, Nose and Throat. Philadelphia: F. A. Davis Co., 1939, p. 690.

30. MAHON, G. S.: Reaction Following Bronchography with Iodized Oil. *Jour. A. M. A.*, 130:194-197, 1946.

31. MANGES, W. F.: Peanut Kernels in the Lungs. Roentgen Ray Diagnosis of Nonopaque Foreign Bodies in the Air Passages. *Surg. Clin. N. Am.*, 4:54-65, 1924.

32. MANN, M.: Lehrbuch der Tracheobronchoskopie. Wurzburg: Curt Kabitzsch, 1914, pp. 92-107.

33. MCCRAE, T.: Clinical Features of Foreign Bodies in the Bronchi. *The Lancet*, pp. 735, 787 and 838, 1924.

34. MORRISON, W. W.: Diseases of Nose, Throat and Ear. Philadelphia: W. B. Saunders Co., 1939, p. 477.

35. PATTERSON, ELLEN J.: Report of Cases of Aspirated Peanuts. *N. Y. State Med. Jour.*, 109:101-103, 1919.

36. PINKERTON, H.: The Reaction to Oils and Fats in the Lung. *Arch. Pathol.*, 5:380-401, 1928.

37. ROSEDALE, R. S.: The Diagnosis of Vegetal Foreign Bodies in the Lower Respiratory Tract. *Ohio State Med. Jour.*, 42:375-377, 1946.

38. SCHENCK, C. P.: Nonopaque Foreign Bodies in the Food and Air Passages. *Ann. Otol., Rhinol. and Laryngol.*, 42:1128-1135, 1933.

39. STILES, M. P.: Vegetable Foreign Bodies in the Trachea and Bronchi: Observations on a Series of 50 Cases. *Ann. Otol., Rhnol. and Laryngol.*, 40:577-595, 1931.

40. TUCKER, G., and CLERF, L.: Foreign Bodies in the Air and Food Passages. *Ann. Otol., Rhinol. and Laryngol.*, 34:5-78, 1925.

41. VINSON, P. P.: Spontaneous Expulsion of a Peanut Kernel One Year After Inspiration. *Arch. Otolaryngol.*, 3:59, 1926.

42. WALDBOTT, G. L.: Correspondence. *Jour. A. M. A.*, 130:599, 1946.

43. WOLF, G. D.: Ear, Nose and Throat. Philadelphia, London and Montreal: J. B. Lippincott Co., 1947, p. 14.

44. WRIGHT, J., and SMITH, H.: Diseases of the Nose and Throat. Philadelphia and New York: Lea and Febiger, 1914, p. 636.

CHORDOMA OF CERVICAL REGION. FURTHER REPORT OF SUCH A CONDITION OPERATED UPON TWO YEARS PREVIOUSLY.*

CHARLES J. IMPERATORI, M.D.,
Essex, N. Y.

Chordomas are uncommon tumors that are vestidial remnants of the notochord (an axial structure characteristic of all vertebrates) and are usually located at sphenoccipital synchondrosis, sacrococcygeal region, and rarely in the lower cervical areas, that is, below the third vertebra.

Normally, portions of the notochord persist in the intervertebral discs as the central mucoid cores or pulpy nuclei (nucleus pulposus).

Livingstone[1] groups these tumors into three classifications:

"*Type 1:* The small tumors called by Virchow 'ecchondrosis physaliphora.' They occur in 2 per cent of postmortem examinations and are composed of the same type of cells as the nucleus pulposus of the intervertebral discs.

"*Type 2:* The malignant tumor in which active mucin-producing cells predominate and in which recurrences and metastasis occur.

"*Type 3:* The main feature of this type is the production of cells which resemble cartilage and the tumors are usually encapsulated, and do not recur."

The desiderata necessary to diagnose a chordoma has been postulated by Linck:[2]

1. Syncytial giant cells.

*Read before the Section on Otolaryngology, New York Academy of Medicine, April 21, 1948.

Editor's Note: This ms. received in Laryngoscope Office and accepted for publication, May 1, 1948.

2. Curious concentric nests of cells.

3. Nuclear vacuolation, the cell possibly filled with glycogen.

Fig. 1. Dec. 8, 1947. This is evidently a local recurrence of the tumor in the same location where it was before. There is a rounded mass encroaching on the entrance to the larynx, not only behind but in front, displacing the epiglottis backward, and there is only a filiform channel as visualized in profile that gives any airway. A thin streak of barium shows in this airway after swallowing. In the A-P projection the tumor lies on the right side.

There is no evidence of involvement in the chest (Dr. R. Spillman, roentgenologist).

This infiltration extends anteriorly from the spinal column, its base being from the lower border of the third to the sixth cervical.

4. Physaliferous cells (the nucleus is located peripherally and the cytoplasm is filled with mucinous globules).

5. Irregular trabeculae of tumor cells separated by abundant intercellular mucinous matrix.

As stated in the case report of April 24, 1947,[3] there was no recurrence of this tumor as of that date. The patient had been previously operated upon in November, 1945, and a chor-

Fig. 2. April 1, 1948. There is no thickening of the retropharyngeal and the retroesophageal tissues in the neck as shown by barium examination, nor do I find anything abnormal in the chest.

The changes involving the fourth and fifth cervical vertebrae are very interesting. At the original examination, Nov. 7, 1945, I reported a little decalcification of the ventral surface of the fourth cervical body, and had no conception of its presumable significance. On Nov. 18, 1946, I noted a bony density apparently originating in the third and fourth cervical bodies and bridging the ventral surfaces. Since then, the process has extended both up and down, and a tongue of bone casting a shadow about 5 x 7 mm. extends down into a notch at the upper ventral angle of the fifth cervical body, and a similar small bony mass is seen just ventral to the lower half of this body. If this process is related to the chordoma, it shows a spontaneous calcification (Dr. R. Spillman, roentgenologist).

This Roentgenogram was taken four months after the removal of the tumor. The lateral portion of the hyoid bone can be seen and the tracheotomy tube in situ.

domatous tumor had been removed from this area. A short summary of the history of the patient is as follows:

Male, 66 years. Machine tool pattern maker. Habits regular. Moderate amount of tobacco and alcohol. Never been ill before. Father died following a colostomy. First complained of some trouble in swallowing in the Fall of 1945. The case history is embodied in a previous report published in the *Annals of Otology, Rhinology and Laryngology*, Vol. 56, No. 2, p. 271.

The patient was symptom-free until the latter part of July, 1947, when he began to experience a sensation of difficulty in swallowing, and within a period of two months had lost considerable weight — approximately 20 pounds — for he now had such difficulty in swallowing that only fluid could be taken. X-rays taken in early December, 1947, showed a recurrence of the tumor growth in approximately the same position (third to sixth cervical vertebra) as in November, 1945. Diagnosis was that of a recurrence of the obstructing tumor mass. The only other symptoms were occasional choking and coughing attacks, probably due to saliva entering the larynx.

The patient entered the Manhattan Eye, Ear and Throat Hospital on Dec. 11. It was proposed to expose the growth by suspension laryngoscopy, as had been done previously, and if the growth could be thus approached by this exposure, encircle it and thus remove it.

Indirect examination seemed to show the growth to be intruding itself laterally into the tissues of the larynx. This was manifested by the edema of the postcricoidal area of the larynx and almost complete obliteration of the laryngopharynx on both sides.

Direct examination, on Dec. 11, 1947, prior to suspension laryngoscopy, confirmed these findings. The appearance was that of a soft mass in the laryngopharynx and, by continuity, a swelling of the arytenoids. This produced a laryngeal obstruction posteriorly. The tumor was soft on palpation with a suggestion of fluctuation. The exposure in the suspension was unsatisfactory, because the lower part of the mass could not be seen, and it was felt that with the limited exposure this method of approach was not to be continued.

These manipulations had taken 20 minutes, and there had developed considerable inspiratory dyspnea. The instruments were removed, and after a period of approximately 10 mintes, when there was no improvement in the breathing, a tracheotomy was done. Patient within a few moments responded under oxygen and stimulation, and was returned to his room. The anesthetic used was ether.

Consideration was given to a subhyoid pharyngotomy as a method of approach. X-ray showed that the lower part of the hyoid was opposite the upper part of the tumor, that is, opposite the lower border of the third cervical. Four days after the first attempt, Dec. 15, a subhyoid pharyngotomy was done. It was found that this approach was also unsatisfactory, for the tissues could not be retracted sufficiently to view the lower part of the growth (sixth cervical). The body of the hyoid bone was removed, but this did not help. (The location of the tumor had been explained to the patient, and he agreed that if the growth could not be properly exposed, and if necessary to do so, his larynx was to be removed.)

The larynx was removed and the anterior wall of the pharynx opened by an incision extending to the upper pharyngeal wall defect, and thus the growth was exposed. The growth encircled the laryngopharyngeal

region and extended downward to the sixth cervical. The tumor was approximately three inches (7.5 cm.) in transverse diameter and approximately three and one-half inches long (9 cm.) and protruded forward (anteriorly) about two inches (5 cm.).

The mucous membrane of the lower pharynx and upper esophagus was incised about four inches in the midline and the tumor, which was partly

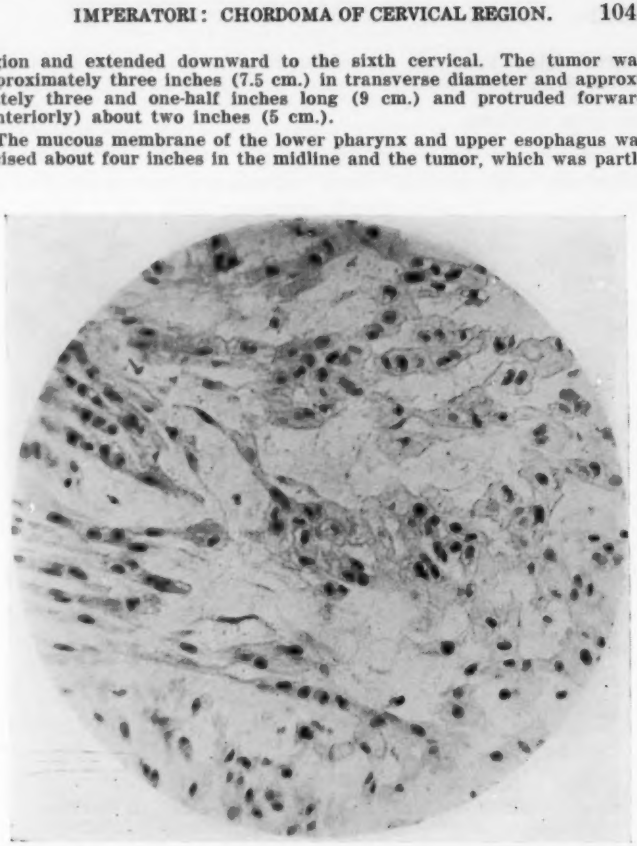

Fig. 3. Showing the arrangement of cells in rows with some few physaliferous cells. These are the vacuolated cells. The stroma has a very fine reticulum throughout and in places appears to be mucilaginous. The magnification is approximately 200×.

encapsulated, excised with the longus cervicis and prevertebral fasciae, etc., so that when removed the bodies of the vertebra, and in the intervertebral discs could be seen on the lower part of the third, all of the fourth, fifth, and upper part of the sixth.

There was some oozing, but this was controlled with gel foam pads, and the incision of the mucous membrane over the site of the tumor was closed with sutures. The rest of the operation completed similar to that following a laryngectomy. The anesthetic was ether.

Patient left the hospital on Dec. 30, 1947. The wound healed without

any difficulty. Following the operation, penicillin was given, approximately 800,000 units every 24 hours. The patient gained 10 pounds within a month following the operation. Pathological diagnosis was that of a recurrent chordoma.

The reason for reporting further on this patient is that after one and one-half years' quiescence and symptom-free,

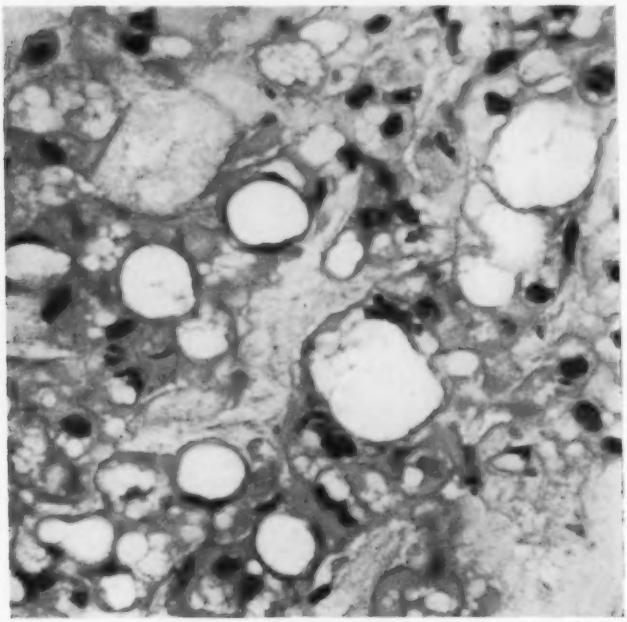

Fig. 4. Showing vacuolated cells of various sizes with the nucleus crowded to one side. These are the so-called physaliferous cells. Magnification 1,000×.

there was a rapid recurrence. What stimulates these vestigial structures to growth is somewhat speculative. Surgery seems to be the only method available in prolonging life in an individual with such a growth.

"The growths are radioresistant, so that X-ray therapy is a failure."[4] The use of a chemical agent such as nitrogen

mustard was tried in another patient, whose growth was at the sphenoccipital synchondrosis, but it was a failure.

The fact that while this type of tumor is invasive, it is not malignant in accepted understanding of such growths. Its invasion of the normal structures of the body either obstructs the airway, the food passages, or the cranial cavity, or the spinal canal, thus interfering with normal function, followed by pressure necrosis, infection, etc.

The present state (April 17, 1948) of the patient is very good, but the prognosis, necessarily, must be held in abeyance.

REFERENCES.

1. Livingstone, Gavin: Chordoma. *Jour. Laryngol. and Otol.*, 50:852, 1935.

2. Linck, A.: Chordoma Malignum, Ein Beitrag Zur Kenntnis der Geschwulste an der Schadelbasis. Jena: Zeigler's Beitrag, 46:573, 1909.

3. Imperatori, C. J.: Chordomas of the Cervical Region, New York. *Ann. Otol., Rhinol. and Laryngol.*, 56:2:271, June, 1947.
p. 959.

4. Stout, A. P.: Human Cancer. Philadelphia: Lea and Febiger, 1932, p. 959.

Essex, N. Y.

THE AMERICAN OTORHINOLOGIC SOCIETY FOR THE ADVANCEMENT OF PLASTIC AND RECONSTRUCTIVE SURGERY, INC.

The Sixth Annual Meeting of the American Otorhinologic Society for the Advancement of Plastic and Reconstructive Surgery will be held at the Palmer House, Chicago, Ill., on Saturday, Oct. 9, 1948. Complete programs may be obtained by writing to the Secretary, Dr. Norman N. Smith, 291 Whitney Avenue, New Haven 11, Conn.

Recent action by the Society provides for associate and corresponding membership in addition to full fellowship. Complete details are available from the Secretary, Dr. Norman S. Smith, 291 Whitney Avenue, New Haven 11, Conn.

CLINICAL EVALUATION OF A NEW ANTIHISTAMINIC COMPOUND.*

ANDREW B. PAUL, M.D.; ANDREW A. EGGSTON, M.D.; CHARLES J. GAROFALO, M.D., and RICHARD J. BELLUCCI, M.D., New York, N. Y.

The histamine concept of allergy has led to various attempts to counteract the toxic effects of this amine, but only the efforts to produce synthetic antihistaminic agents yielded results of considerable clinical usefulness. Indeed, the advent of these histamine antagonists is one of the remarkable recent achievements in therapeutics.

It is not within the scope of this paper to discuss the entire range of investigations and findings leading to the development of those antihistaminic compounds now used in the management of allergic diseases. The interested reader is referred to the comprehensive review article by Feinberg[1] on the experimental and therapeutic status of histamine and antihistaminic agents. Suffice it to say that studies conducted by French scientists (Fourneau, Bovet, Halpern) have led to the discovery of two groups of amines possessing antihistaminic activity: The compounds of one group are derivatives of ethanolamine and those of the other, derivatives of ethylenediamine. Some of these drugs are very effective in combating allergic manifestations, but in a great number of patients they produce toxic reactions among which sedation and drowsiness are most frequently encountered. The idea suggested itself that the untoward effects might be intimately associated with the ethanolamine or ethylenediamine structure; therefore, Wenner and Plati[6] set out to develop histamine antagonists of a fundamentally different structural

*Department of Allergy, Manhattan Eye, Ear and Throat Hospital, New York, N. Y.

Editor's Note: This ms. received in Laryngoscope Office and accepted for publication, April 23, 1948.

formula. They searched for amines whose molecular weight would approximate that of the antihistaminics in clinical use. The synthesis of organic bases was undertaken which contained the amine function in the form of a piperidine nucleus, the pharmacologic properties of which are well established. One of the compounds synthesized in the course of this work was distinguished by great antihistaminic activity and at the same time by low toxicity in animal experiments. The formula of this substance was elucidated as 2-methyl-9-phenyl-2,3,4,9-tetrahydro-1-pyridindene. Of the various salts prepared of this base, the hydrogen tartrate was submitted to us for clinical evaluation under the designation of NU-1504* and later under the name of Thephorin.*

PHARMACOLOGY.

The pharmacology of NU-1504 was explored extensively by Lehmann[2,3] and some of his observations are summarized here.

In acute toxicity experiments in mice, NU-1504 proved about as toxic as Benadryl, but, by the intravenous route, only one-half to one-third as toxic as Pyribenzamine. There was no evidence of chronic toxicity from NU-1504 in rats and dogs as evidenced by the following experiments. Diets containing 0.025 per cent and 0.05 per cent of NU-1504 were fed to rats for six months without causing any ill effects upon growth and blood formation. Pathological tissue changes were not observed. Similarly, the daily administration of 200 mg. of NU-1504 for six months to two dogs and of 100 mg. for five months to three dogs had no adverse influence on weight, blood formation, blood glucose and nonprotein nitrogen. The two dogs which had received 200 mg. daily for six months, corresponding to a total dose of 36 gm., were sacrificed. Tissue examination revealed no pathological changes.

The spasmogenic effect of histamine on the isolated intestine of the guinea pig was abolished by NU-1504. The same was true of spasm induced by acetylcholine and Ba^{++}.

*The writers are indebted to Hoffmann-La Roche, Inc., Nutley, N. J., for liberal supplies of NU-1504 (Thephorin) in the form of 25 mg. tablets and of syrup containing 10 mg./4cc.

*"Roche" brand of phenindamine.

Eleven of 12 guinea pigs having received 2 mg./kg. of NU-1504 by intraperitoneal injection 30 minutes before exposure to atomized histamine phosphate were protected for six minutes against convulsions which were produced in one to two minutes if nonprotected animals were exposed to the histamine spray.

All of 40 guinea pigs having received 4 mg./kg. of NU-1504 intraperitoneally one-half hour prior to their exposure for 10 minutes to atomized histamine phosphate survived. Of a similar group of nonprotected controls, 43 out of 44 guinea pigs died.

Five mg./kg. of NU-1504 administered intraperitoneally protected all of 13 guinea pigs against five fatal doses of intracardially injected histamine.

In another experiment, guinea pigs were sensitized by the intraperitoneal injection of 2 cc. of a 10 per cent egg white solution. Shock was produced 19 days later by the intracardiac administration of 0.5 cc. of a 2 per cent egg white solution. Only one out of 12 animals survived; however, if 2 mg./kg. of NU-1504 were injected intraperitoneally one-half hour prior to the shocking egg white dose, 58 per cent of the animals were protected.

The hypotensive effect of intravenously administered histamine phosphate in the anesthetized cat was abolished or greatly diminished by NU-1504. The same was true of the histamine-induced vasopressor effect in decapitated cats. The increase of capillary permeability induced by histamine was counteracted, to some degree, in the rabbit and in man by administration of NU-1504.

With this pharmacological evidence of low toxicity and effectiveness in antagonizing important physiological actions of histamine, clinical trials with NU-1504 were instituted.

CASE MATERIAL.

Thephorin was evaluated in 301 patients. The majority of these presented themselves at the Allergy Clinic of the Man-

hattan Eye, Ear and Throat Hospital and a small number at our private offices. Actually, Thephorin was used in additional patients; however, all subjects reporting improvement and whose reliability had not yet been determined previously when they received another antihistaminic drug were placed on placebo medication at one time or another without their knowledge, and those who claimed continued relief were excluded from the study. As appears in Table 1, 197 of the 301 patients studied suffered from hay fever, 71 from nonseasonal vasomotor rhinitis, and 12 from bronchial asthma; 17 exhibited various cutaneous allergies and four, miscellaneous allergic manifestations. Seventeen of the 21 subjects constituting the latter two categories derived benefit from Thephorin — a high incidence of improvement — but the small numbers of instances representative of the individual diagnoses within the two categories rendered these 21 cases unsuitable for

TABLE 1. DIAGNOSES AND RESULTS OF TREATMENT WITH THEPHORIN IN 301 ALLERGIC PATIENTS.

Diagnosis	Total	Results			
		Fair to Excellent		Negative	
		No.	%	No.	%
Bronchial Asthma	12	6	50	6	50
Angioneurotic Edema	4	4	100		
Conjunctivitis	2			2	100
Dermatitis	3	3	100		
Hay Fever	197	154	78.2	43	21.8
Sinusitis	1			1	100
Urticaria (acute and chronic)	10	10	100		
Vasomotor Rhinitis	71	54	76.1	17	23.9
Migraine	1			1	100
Total	301	231	76.7	70	23.3

appraisal of the merits of the new drug in the conditions involved. Also, it is often more difficult in, for instance, allergic skin diseases, particularly of the acute variety, than it is in nasal allergies and also in bronchial asthma, to attribute, with certainty, the improvement attained to a therapeutic measure. Indeed, in most cases of allergic rhinitis and of asthma it is possible to study the effects of a given drug on repeated occasions and to determine the results of its discontinuance as well as of placebo medication; furthermore, cri-

teria for both objective and subjective improvement can be more readily established in these latter conditions. Further discussion, therefore, will be confined to the 268 cases with nasal symptoms and the 12 cases with a diagnosis of bronchial asthma. Of these 280 patients, 30 were children (20 boys and 10 girls), ranging in age from four to 12 years. The adolescents were grouped together with the adults, totaling 250 subjects. Their ages ranged from 13 to 69 years.

PROCEDURE AND RESULTS.

Skin testing and a rhinolaryngological examination were performed routinely for every patient; furthermore, in all cases of seasonal and nonseasonal vasomotor rhinitis, the nasal smear was studied cytologically. These combined examinations aimed at establishing the presence of an allergic disease.

The entire series may be divided as follows: One group of 224 patients who had been given perennial or preseasonal hyposensitization therapy — which, however, did not control them adequately — and a second group of 56 patients who presented themselves for the first time, had had no hyposensitization therapy and were given injections of physiologic saline solution in place of specific extract treatment. To the patients of both groups Thephorin was prescribed. The purpose of the administration of placebo injection was to make these patients believe that they received the same kind of medical attention as all the others; however, no attempt will be made to compare results obtained with Thephorin alone on the one hand and with Thephorin plus hyposensitization therapy on the other, since such a comparative evaluation should preferably be undertaken in groups of fairly equitable sizes. Thephorin was given after meals. Initially, we had to feel our way to determine the effective dosage. It soon became apparent that 25 mg. was an adequate individual dose in most of the adult patients who derived benefit from the drug; and that in children, depending on age, 10 mg. (one teaspoon of the syrup) or 25 mg. (one tablet) were similarly effective. The onset of action was fast, often being noticeable in 15 minutes. The relief obtained from a single dose lasted an

average of four to five hours, with some patients reporting satisfactory improvement for eight to 10 hours and with others stating that the relief lasted for only two to three hours. The intelligent adult patient was, therefore, instructed to take one tablet whenever symptoms became markedly aggravated, but not to use more than six tablets a day. Thus, the daily dosage ranged from 25 to 150 mg., with most of the adults taking the drug on a t.i.d. basis (daily intake, 75 mg.) and with most children receiving 10 mg. three times a day.

The duration of treatment varied greatly: Thephorin was given for only several days in 11 patients who experienced rather severe side effects necessitating discontinuance of the medication; on the other hand, six patients took 75 mg. daily over a period of several months; however, the average duration of treatment was 17 days.

Of the 12 patients with bronchial asthma, six, or 50 per cent, were helped by Thephorin, with results being good to excellent in five and fair in one.*

Of the 197 patients with hay fever, 154, or 78.2 per cent, were benefited, and 43, or 21.8 per cent, were not, or insignificantly, improved. Good to excellent relief was obtained in 115 patients, or 58.4 per cent, and fair relief in 39, or 19.8 per cent. The patients had markedly less rhinorrhea, itching and sneezing. There was definite improvement of the blocking of the nose at the beginning of the season, but as the pollen count increased, complaints about "stuffy noses" became more frequent.

Of the 71 patients with nonseasonal vasomotor rhinitis, 54, or 76.1 per cent, were helped by Thephorin, and 17, or 23.9 per cent, were not or not conclusively improved. The relief was good to excellent in 45, or 63.4 per cent, and fair in nine, or 12.7 per cent.

Table 1 records the overall results, and Table 2 summarizes the degrees of the favorable responses obtained for the cases of asthma and nasal allergies.

*It is realized that results in a group of 12 patients are not significant.

A study of the nasal smears carried out at the onset of Thephorin medication for all patients with hay fever and nonseasonal vasomotor rhinitis revealed an increase in the number of eosinophile cells in approximately 80 per cent of these cases. Differential blood counts paralleled these findings, inasmuch as individuals with a high eosinophilic count in the nasal smear showed more than 3 per cent eosinophile cells in the blood. There was fair agreement between the degree of symptomatic improvement derived from Thephorin and the reduction of the eosinophile cells in the nasal smear on subsequent counts.

TABLE 2. DEGREES OF FAVORABLE RESPONSES OBTAINED WITH THEPHORIN IN 280 PATIENTS WITH A DIAGNOSIS OF BRONCHIAL ASTHMA, HAY FEVER AND VASOMOTOR RHINITIS, RESPECTIVELY.

Diagnosis	Total	Results			
		Good to Excellent		Fair	
		No.	%	No.	%
Bronchial Asthma	12	5	41.7	1	8.3
Hay Fever	197	115	58.4	39	19.8
Vasomotor Rhinitis	71	45	63.4	9	12.7

Discontinuance of Thephorin was always attended by aggravation of symptoms. Similarly, the administration of placebo medication given in place of Thephorin resulted invariably in the reappearance or aggravation of symptoms. The placebo tablets employed simulated the Thephorin tablets in size, color and shape and the nonmedicated syrup was identical in color, taste and consistency with Thephorin syrup.

No serious toxic symptoms have been observed in any of the patients receiving Thephorin. It is worthy of note that with the dosage employed none of the subjects experienced sedation or drowsiness; however, 75 patients, or 26.7 per cent of the 280 cases detailed in this report, complained of side reactions. These were encountered particularly in persons receiving a total daily dose of 150 mg. Only in 11 persons, or 3.9 per cent, were the untoward by-effects sufficiently severe to warrant discontinuance of Thephorin. Incidentally, results in these patients were recorded as failures. Side reactions were conspicuous by their absence in the 30 children treated,

who all tolerated a daily dose of 30 to 50 mg. exceptionally well.

As appears from Table 3 listing the incidence of the more frequently occurring side reactions, insomnia was experienced by 18 patients, or 6.4 per cent; furthermore, it can be seen from this table that sleeplessness and nervousness were the most common reactions. The patients described their feel-

TABLE 3. DISTRIBUTION OF THE MORE FREQUENT SIDE EFFECTS OF THEPHORIN IN 280 PATIENTS.

Side Effect	No.	%
Sleeplessness	18	6.4
Nervousness	15	5.4
Chills	9	3.2
Nausea	10	3.6
Headache	8	2.9
Dryness of Mouth and Throat	6	2.1

ing as one of restlessness, "jitteriness," which sometimes kept them awake on retiring. Some subjects stated that the tablets gave them "a lift." Undoubtedly, then, Thephorin produced stimulation in about 12 per cent of the patients. This, however, was promptly controlled by phenobarbital, $\frac{1}{4}$ gr. t.i.d. or $\frac{1}{2}$ gr. at bedtime if insomnia was the main complaint. The stimulating action of the drug was not attended by a hypertensive effect as determined by repeated blood pressure readings. Similarly, there was no significant increase of the pulse rate. Three patients each received 75 mg. of Thephorin daily for three months and four months, respectively; general physical examination, including complete hemograms, urinalysis, blood chemistry and electrocardiographic tracings done for these six persons initially, at monthly intervals, and terminally showed no significant changes.

DISCUSSION.

It is evident from the findings reported that Thephorin is a very effective antihistaminic compound. The incidence of success in the indications studied equals that obtained with the best histamine antagonists; however, Thephorin is distinguished by one very attractive feature; namely, that it lacks

the depressant effects which are so prominent with the antihistaminic drugs of the ethanolamine and ethylenediamine structure. It appears that the pyridindene derivative, Thephorin, which belongs to a heretofore unknown class of compounds with antihistaminic activity, possesses a stimulating effect rather than a depressant action. Stimulation, if present, can be easily combated whenever necessary by the conjoined administration of a mild sedative-hypnotic. In general, untoward effects following the administration of Thephorin are of a mild nature and of lesser consequence than with the antihistaminics previously employed.

Reynolds and Horton[5] have recently reported their observations with Thephorin. The incidence of success recorded by these workers in hay fever is 95 per cent and that in nonseasonal vasomotor rhinitis, 64 per cent. It thus appears that their results were still better than ours in hay fever, whereas in nonseasonal allergic rhinitis the opposite is true. Reynolds and Horton look upon Thephorin as "a useful drug" and they state that "the small dosage required for the control of symptoms and the uniform absence of toxic manifestations seem to be the outstanding advantages of this agent over other antihistamine agents."

McGavack[4] studied the toxicologic effects of Thephorin at varying dosage levels in 100 human subjects. With a daily dose of 75 mg., the incidence of untoward side reactions observed by him was 15.4 per cent and with a daily dose of 150 mg. it was 24.1 per cent. The incidence of by-effects in the 280 patients presented in this report and whose daily dosage ranged from 25 to 150 mg. was 26.7 per cent. Thus, our findings are in good agreement with those of McGavack. This worker also compared the incidence of unpleasant reactions caused by Thephorin, on the one hand, and by Benadryl and Pyribenzamine, on the other. At a dosage level of 150 mg., Thephorin was found to be less than one-half as toxic as either of the two other drugs. While we did not attempt such a comparative evaluation, it has been our experience, as well as that of Reynolds and Horton, that Thephorin is distinguished by low toxicity.

SUMMARY AND CONCLUSIONS.

Thephorin, which is chemically 2-methyl-9-phenyl-2,3,4,9-tetrahydro-1-pyridindene hydrogen tartrate, and represents an entirely new type of antihistaminic compound, was evaluated clinically in 301 patients with various allergic manifestations. The results obtained in 280 of these subjects are herewith presented. They suffered from asthma, hay fever and nonseasonal vasomotor rhinitis. In the majority of instances, hyposensitization therapy, which however, did not control the patients adequately, was given in addition to Thephorin. The daily dosage of the new antihistaminic drug ranged from 25 to 150 mg. Most of the adults took 75 mg. and most of the children 30 mg. a day.

Results were as follows: 50 per cent of the asthma cases, 78.2 per cent of the patients with hay fever and 76.1 per cent of the nonseasonal vasomotor rhinitis cases were helped, with the degree of relief ranging from fair to excellent. Placebo medication failed to produce relief. Side effects occurred in 26.7 per cent of the cases. Only in 11 patients, or 3.9 per cent, were these sufficiently severe to warrant discontinuation of Thephorin. The most commonly encountered reaction was a stimulating effect. This could be counteracted by the conjoint administration of a mild sedative hypnotic. Thephorin did not produce drowsiness.

Neither Thephorin nor any of the other histamine antagonists have a curative effect. The relief obtained from a single dose of 25 mg. of Thephorin lasted an average of four to five hours.

On the basis of these findings, it is concluded that Thephorin is a clinically very useful preparation in the symptomatic treatment of allergic conditions, that it is effective in small dosage and that side effects are generally of a mild nature and of lesser consequence than with other antihistaminic substances established in therapeutics.

ACKNOWLEDGMENT.

We are indebted to Dr. Leo A. Pirk for his untiring efforts in connection with this project, and to Miss Gloria Quinn for her technical assistance.

REFERENCES.

1. Feinberg, S. A.: Histamine and Antihistaminic Agents; Their Experimental and Therapeutic Status. *Jour. A. M. A.*, 132:702-713, Nov. 23, 1946.

2. Lehmann, G.: Personal communication.

3. Lehmann, G.; Hagan, E.; Barbarow, G., and Roe, M.: The Antihistamine Action of Pyridindene Derivatives. *Fed. Proc.*, 6:350, 1947.

4. McGavack, T. H.: Personal communication. Boyd, L. J.; Weissberg, J., and McGavack, T. H.: Tolerance Studies of the Antihistamine Drug Thephorin. *N. Y. State Jour. Med.* (in press).

5. Reynolds, J. L., and Horton, B. T.: Clinical Observations on the Use of Thephorin (NU-1504): A New Antihistaminic Agent. *Proc. Staff Meet., Mayo Clin.*, 22:574, Dec. 10, 1947.

6. Wenner, W., and Plati, J. T.: Synthesis of Pyridindene Derivatives. To be published.

SOUTH CAROLINA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY.

A joint meeting of the South Carolina Society of Ophthalmology and Otolaryngology and the North Carolina Eye, Ear, Nose and Throat Society was held in Charleston, S. C., Sept. 13-16, 1948. The Francis Marion Hotel was headquarters. The first two days were devoted to ophthalmology and the last two to otolaryngology. Four outstanding men had been secured in each of the above specialties.

RATIONAL FOR REMOVAL OF EVERY VESTIGE OF DEVIATED NASAL SEPTUM.

E. MARKEY PULLEN, M.D.,
New York, N. Y.

A needed and well done submucous resection can do the least harm and the most good of any operation on the body. If there is any interference with nasal respiration, functional activity of the inferior turbinates, ventilation of the middle and superior meatuses and accessory sinuses, or to the drainage of these areas,[1] an operative procedure is definitely needed. If the operation is to be effective, it is well to remove *every* vestige of deviated framework, regardless of its extent.

Contemporary orthodoxy, however, still adheres to the concept that a generous submucous resection may cause saddling of the dorsum and drooping of the tip, for it is believed that maintenance of the profile projection of the nasal pyramid is dependent mainly upon support furnished by the septum.[2,3] Medical literature continues to report that removal of the cartilage too near the ridge of the nose may cause complications,[4,5] and that to avoid them, a cartilage ridge at least one-fourth inch in depth should be left to support the external nose. In a number of cases of submucous resection, therefore, parts of septal cartilage are retained, even when these are in themselves major causes for disturbed physiologic activity.

Anatomic, physiologic, mechanical and clinical facts are herewith presented to show: *1.* that the septum, under static conditions, is a redundant member, offering no support; *2.* that saddling of the nose following a generous submucous septal resection, drooping of the tip, distortion of the lobule and asymetry of the nares following removal of the caudal end of the septum, are due to cicatrization of connective tissue and are not the result of lack of septal support.

Editor's Note: This ms. received in Laryngoscope Office and accepted for publication, June 4, 1948.

The septum has been arbitrarily divided into an anterior and posterior part by an imaginary line extending from the nasal spine of the frontal bone to the nasal spine of the maxillae. The anterior part, in which submucous resection is under controversy, is subdivided into *1.* the osseous vault septum, *2.* the upper cartilaginous vault septum, and *3.* the lower cartilaginous vault septum.

OSSEOUS VAULT SEPTUM.

Anatomic Considerations: The apex of the osseous vault is the nasal process and nasal spine of the frontal bone; the walls comprise the two nasal bones which articulate laterally

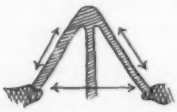

Fig. 1. Cross-section of nose showing lateral walls (nasal bones and frontal processes of maxillae) are struts or rigid arches, resting on maxillary abutments. Arrows indicate direction of supporting forces.

with the frontal processes of the maxillae, firmly supported on maxillary abutments. The septum of the osseous vault is formed by the nasal crest, nasal spine of the frontal, septal cartilage and the perpendicular plate of the ethmoid.

According to Schaeffer,[6] the perpendicular plate of the ethmoid represents the ossified part of the primitive cartilaginous nasal capsule. It articulates ventrally with the septal cartilage, the nasal crests and the nasal spine of the frontal; cephalically, with the cribriform plate; dorsally, with the crest of the sphenoid, caudally, with the vomer.

The perpendicular plate of the ethmoid varies in size, as is shown in any skull series; therefore, the septal cartilage, which articulates with it, is reciprocally large or small.

Mechanical Considerations:[7,8,9] By employing the principle that a body is in equilibrium if the sum of all horizontal and vertical forces balance out, it can be proved that the septum

is a redundant member under static conditions, furnishing no support whatever; and that only when crushing forces from without or traction forces from within are applied does it become a factor of support (see Fig. 1).

Clinical Considerations: It is acknowledged that the external architecture of the osseous vault will not be changed by removal of the perpendicular plate of the ethmoid. Cicatricial contractions in the mucoperiosteal membranes, regardless how extensive, are unable to change the construction of this arch.

Fig. 2. Sagittal section showing anatomic attachment of upper cartilaginous gable. Upper lateral cartilages (solid black) attached above to under surface of nasal bones and frontal processes of maxillae by aponeuroses. Below they underride lower lateral cartilages (cross-hatched).

UPPER CARTILAGINOUS VAULT SEPTUM.

Anatomic Considerations: A quadrilateral piece of cartilage, together with the two upper lateral cartilages which diverge from it in a wing-like manner and give support to the middle third of the nose, form the middle cartilaginous vault. There is both embryologic and morpholologic reason to consider the upper lateral cartilages as being an integral part of the septum.

The upper lateral cartilages, which vary in size and shape — being convex or concave — are attached cephalically to the *under* surface of the nasal bones and frontal processes of the maxillae by strong fibrous tissue aponeuroses. Although the cartilages usually extend to the agger nasi, they may reach the base of the nasal spine of the frontal bone. Caudally, they *underride* the lower lateral cartilages (see Fig. 2). Their dorsal borders are attached to the maxillae and the nasal bones; the ventral borders are fused with the cartilage of the septum

and, as mentioned previously, are wedged under the nasal bones for a varying distance.

The septal cartilage, quadrilateral in shape, is attached dorsocephalically to the perpendicular plate of the ethmoid, and dorsocaudally to the vomer and maxilla as far as the anterior nasal spine. The septal cartilage extends dorsally for a variable distance between the vomer and the perpendicular lamina of the ethmoid, thus forming the sphenoidal process of the septal cartilage. The ventrocephalic border is attached along the internasal suture above, and lateraly it becomes confluent with the upper lateral cartilages.

Physiologic Considerations: This portion of the vault, because of its cartilaginous nature, gives the rigidity and elasticity required to carry on proper nasal physiology. It maintains an adequate total capacity and yet permits variations in shape for respiration and expression. The vault also acts as a buffer to diffuse forces applied to the nose and thereby protects the anterior cranial fossa.

The upper lateral cartilages function as an air channel, regulating the size and velocity of the air currents. On deep inspiration these cartilages are brought close to the midline, lessening the volume of the air intake and breaking it into thinner laminae. This prevents too rapid evaporation of secretions and cooling of the mucous membrane.

Mechanical Considerations: Sufficient stability to maintain profile projection under static conditions is secured by the anatomic attachment of the upper cartilaginous gable to the under surface of the nasal bone and the frontal processes of the maxillae.

The cantilever principle can be applied to the anatomic relationship of the osseous and cartilaginous gables; that is, the more the cartilage gable extends beneath the distal edge of the osseous gable, the greater is its achieved stability under stress.

Clinical Considerations: The Fomon group has demonstrated hundreds of times in the course of rhinoplastic opera-

tions that the upper lateral cartilages will maintain the profile projections of the nose without the aid of the septum. It is to be particularly noted that saddling following an extensive resection occurs almost invariably not at the time of the operation but some weeks later. This is believed to be the result of operative trauma. If the upper lateral cartilages are felt at the time when forceps are placed on the septum, the movement is noted on the outer cartilaginous vault. *It is during this procedure, when force is applied to the septum, that the aponeuroses attachments of the upper lateral cartilages are torn. Later, cicatricial tissue causes the deformity.* If the septum was the supporting element, this complication should occur immediately.

The fact that saddling occurs at a later time bears out the statement that the deformity is not due to lack of support, but rather to tension forces arising from cicatricial contraction. In the exceptional case when saddling occurs immediately, it is the swinging away of the upper lateral cartilages from the septum at an unusually high level (cephalad which brings this about. This occurs in association with insufficiently developed lower lateral cartilages which are unable to bridge the intervening space. Only in such rare instances does the septum furnish stability.

LOWER CARTILAGINOUS VAULT SEPTUM.

Anatomic Considerations: The lower lateral cartilages overlap the upper lateral cartilages, to which they are attached by an aponeurosis. They are horseshoe shaped and partly encircle the ventral part of the nares. Each lower cartilage consists of a mesial and a lateral crus.

The mesial crus is attached by a membranous aponeurosis to the cartilage of the septum and lies in the columella. Ventrally, it abuts the mesial crus of the opposite side and ends dorsally in two free out-turned extremities.

The lateral crus is attached to the maxilla dorsally by a strong sheet of fibrous tissue in which are embedded the lesser alar cartilages. Ventrally, it becomes confluent with the angle;

cephalad, it is attached to the upper lateral cartilage by a fibrous membrane and to the caudoventral part of the cartilaginous septum; caudad, the cartilage falls short of the margin of the nares.

Physiologic Considerations: The lower lateral cartilages aid in keeping the nares and vestibules open, and control the shape and direction of the air currents; furthermore, they are active in expression and phonation.

Mechanical Considerations:[10] Structurally, the lower lateral cartilages are comparable to a cantilever bridge, such as the Forth bridge, and to a double-arched bridge with the footing of each pier hinged on its foundation, so as to permit rocking. The cartilage angles are the "arches," the lateral crura and alar pad of connective tissue the "piers," the bony margin of the pyriform opening of the maxilla the "foundation," and the connective tissue hinged by crossed fibroelastic fibres attached to the periosteum on the maxillary process form the "footings." The advantage of this construction is that it can be built more slenderly and any bending stresses developed in it have full play because of the hinges.

Clinical Considerations: The following clinical observations bear out the statement that the lower vault is even less dependent for support upon the septal cartilage than are the upper and middle vaults.

1. The lobule maintains its original position and contour, despite the complete separation of the lower cartilaginous vault from the upper cartilaginous vault in the typical rhinoplasty. To expose the nasal skeleton, a primary incision is made between the upper and lower lateral cartilages on both sides and a button-end knife is carried from one incision to the other and the membranous septum cut through.

2. The tip of a saddle nose still maintains its projection.

3. The removal of a triangle from the septal cartilage, for the purpose of shortening a long nose, has no effect on the position of the lobule.

OPERATIVE PROCEDURES.

The following operative procedures, based upon the above anatomic, physiologic and mechanical effects show *1.* that the septum; under static conditions, is a redundant member, offering no support; *2.* that saddling of the nose following a generous submucous resection, and the dropping of the tip, distortion of the lobule and asymmetry of the nares following removal of the caudal end of the septum are due to cicatrization, and not the result of lack of septal support.

The incision or scratch in the septal cartilage is not made on the same level as the primary incision — at least 0.25 to 0.5 cm. intervening between the two. Thus, if the mucous membrane of the opposite side is accidentally cut, the incisions will not be in apposition and, therefore, a permanent perforation will not result (see Fig. 3). Another precautionary method against perforation is gently to break the cartilage by twisting or pushing the nose from side to side after having scratched a line of breakage with the scalpel; however, if a perforation does result, a piece of cartilage placed between the flaps and covering this area will insure healing of the membrane.

Fig. 3. Preventing permanent perforation. Incision in septal cartilage (stippled area) not made on same level as primary incision.

Every vestige of deviated framework of the septum is removed. Regardless of its location, the obstructing cartilage is deleted as far ventrad or caudad as is necessary. Since the septum is a redundant member under static conditions, an immediate sinking-in of the ridge of the nose or drooping of

the tip from a too ventral or caudal, a resection is not to be feared, providing measures are taken to prevent subsequent deformities.

The measure deemed necessary to prevent contractile deformities is the reinsertion between the flaps of as large a piece of cartilage as possible. The choice of the material depends upon the conditions present; if the resected cartilage is usable or can be made usable by shaving or cross-hatching,

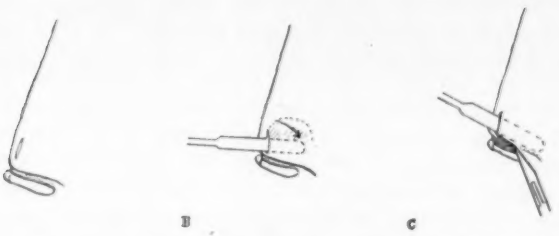

Fig. 4. L-shaped primary incision simplifies approach to columella. (A) Short limb of incision, approximately 1 cm. in length, made parallel to ridge of nose and as near dorsum as possible. (B) Septal elevator inserted and with gentle pressure and sweeping motion brought downward to floor of nose and forward to mucocutaneous junction. (C) With elevator left in place, long limb of primary incision made by cutting along edge of retained instrument at mucocutaneous junction.

it is preferred; otherwise, isografts of septal cartilage preserved in merthiolate solution are used.[4]

When a rhinoplasty is to be performed several weeks after a submucous resection, it is particularly essential to insert as much intact cartilage as posible.

If it is desirable to have the initial incision at the mucocutaneous junction, the author uses an L-shaped mucous membrane and perichondrial cut (reverse L-shaped on left side). The short limb, approximately 1 cm. in length, is made parallel to the ridge of the nose and as near the dorsum as possible (see Figs. 4A and 4B). A septal elevator is then inserted, and with gentle pressure and sweeping motion the instrument is brought downward to the floor of the nose and forward to the mucocutaneous junction. With the elevator left in place,

the long limb of the L-shaped incision is now made by cutting along the edge of the retained instrument at the mucocutaneous junction (see Fig. 4C). If columella work is desired, this incision simplifies the approach to the area.

When retraction of the columella is feared, a bed is prepared in this tissue during the submucous resection. The two laminae are separated with a No. 15 Bard Parker and a Stevens scissors (see Fig. 5A). A cartilage graft is then

Fig. 5. Preparing bed in columella for "columella strut" when retraction is feared. (A) Two lamina separated with a No. 15 Bard Parker. Stevens scissors also used. (B) Graft retained in place with two sutures.

introduced between the two layers, which are held apart with dural hooks. One or two through-and-through silk mattress sutures passed behind the graft retain it in place (see Fig. 5B). The thickness and width of the graft varies from 2 to 4 mm., depending upon the amount of contraction anticipated. Its length averages 2.5 to 3 cm., depending upon the length of the tip. The mucous membrane flap is always sutured.

This cartilaginous graft is inserted not as a support, for it has no abutment to the lower lateral cartilages or to the nasal spine of the maxillae. It is introduced merely to prevent retraction of the columella caused by inevitable pull of contracting connective tissue in the septal flaps.

As suggested by Galloway,[11] a large cartilaginous graft is introduced in the prepared bed of the columella and between the flaps of the mucous membrane after first passing a suture with a needle on each end through the entire thickness of one

end of the graft; a similar suture is passed through the adjacent corner of the side that will fit into the columella (see Fig. 6A). The two needles of one corner are then passed through the tip of the nose and the other two needles through the base of the columella. These traction sutures are then held taut by the assistant while the mucous membrane flap is sewn and the two mattress sutures are passed through the columella to hold the graft in place. The traction sutures are then removed (see Fig. 6B).

Through clinical experience, it is found that there is little danger of the cartilage graft not "taking." Since cartilage is

A B

Fig. 6. Cartilage replacement. (A) Suture with needle on each end passed through entire thickness of one corner of side that fits into columella; repeated at other corner with similar suture. (B) Two needles of one corner of graft passed through tip of nose and other two needles through base of columella. Then sutures held taut for traction while mucous membrane sewn and two mattress sutures passed through columella holding graft in place.

lymph-nourished, it immediately receives nourishment through imbibition; it retains its original morphology, does not become absorbed or tend to shrink or disintegrate. Although isografts are foreign bodies, they are well tolerated by the tissues.

The graft has no abutment above or below and, therefore, can sustain no weight or furnish support. Like the columella strut, the cartilage replacement prevents contraction of the connective tissue during the process of healing, and thus eliminates the consequent distortion, such as flapping or sagging when lying on side, and saddling of the nose; furthermore, because it restores the rigidity of the partition and counteracts the ballooning effects of peak positive and negative

pressures during respiration, such reconstruction of the septum would appear more effective.

After the excision of large deviations or spurs, the floor of the nose is elevated and a section of the mucous membrane near the floor on the side of the convexity is removed to prevent contraction and pulling the septum out of alignment. The length and width of the excised membrane vary with the individual case.

Whenever there is a large concavity on one side, there is a compensatory hypertrophy of its middle turbinate in order to fill in the space. Conversely, on the opposite side the turbinate will be impinged on the septum and the lateral wall; therefore, to overcome this the turbinate in the convex or small side is fractured, allowing it to fall into its normal position. The hypertrophied turbinate is crushed with a flat crushing forceps; however, if the turbinate is quite large, the mucous membrane is elevated and a section, according to the size required, is dissected out.

CONCLUSIONS.

From anatomic, physiologic, mechanical and clinical data on the osseous, upper and lower cartilaginous septum, the following conclusions may be drawn:

1. The septum, under static conditions, is a redundant member offering no support.
2. Saddling of the nose following a generous submucous septal resection, and the drooping of the tip, distortion of the lobule and asymmetry of the nares following removal of the caudal end of the septum, are due to cicatrization of connective tissue and not the result of loss of septal support. Complication occurs almost invariably, not at the time of operation but some weeks later.
3. *Every* vestige of deviated framework of septum may be removed regardless of location, providing measures are taken to prevent subsequent contractile deformities.

4. Reinsertion of as large a piece of cartilage as possible between the flaps is deemed necessary to prevent cicatricial contraction.

5. Columella strut: to prevent retraction of the columella, caused by inevitable pull of connective tissue in the septal flaps, a piece of cartilage is inserted.

6. Upper lateral cartilages will maintain the profile projections of the nose without the aid of the septum.

7. The L-shaped incision used by the author simplifies the approach to the columella.

8. A permanent perforation in the septum will not result if the incision in the septal cartilage is not made on the same level as the primary incision.

BIBLIOGRAPHY.

1. Ballenger, W. L., and Ballenger, H. C.: Diseases of the Nose, Throat and Ear, Medical and Surgical. Ed. 8. Philadelphia: Lea and Febiger, 1943.

2. Salinger, S.: Deviation of the Septum in Relationship to Twisted Nose. *Arch. Otolaryngol.*, 29:520, Mar., 1939.

3. Metzenbaum, M.: Replacement of Lower End of Dislocated Septal Cartilage Versus Submucous Resection of Dislocated End of Septal Cartilage. *Arch. Otolaryngol.*, 9:282, Mar., 1929.

4. Fomon, S.: The Surgery of Injury and Plastic Repair. Baltimore: Williams and Wilkins Co., 1939, p. 714, pp. 182-183.

5. Coakley, C. G.: A Manual of Diseases of the Nose and Throat. Ed. 7. Philadelphia, Lea and Febiger, 1930, pp. 163-164.

6. Schaeffer, J. P.: The Nose, Paranasal Sinuses, Nasolacrimal Passageways and Olfactory Organ in Man. Philadelphia: P. Blakistons' Son and Co., 1920.

7. Poorman, A. P.: Applied Mechanics. Ed. 4. New York: McGraw-Hill Book Co., Inc., 1940, Secs. 20-22.

8. Chambers, S. D., and Faires, V. M.: Analytical Mechanics. New York: Macmillan, 1943, Secs. 16-18.

9. Lerner, S.: B.S., M.S., Assistant Professor of Engineering, Brown University. Unpublished data.

10. Thompson, D. W.: On Growth and Form. New York: Macmillan, 1942, p. 992.

11. Galloway, T. C.: Unpublished data.

30 East 40th Street.

SOCIETE FRANCAISE D'OTO-RHINO-LARYNGOLOGIE
XLV° CONGRES.

The Forty-sixth French Congress of Oto-Rhino-Laryngologie will have its meetings in the Grand Amphitheater of the Faculty of Medicine of Paris from Oct. 18 to 23, under the presidency of Mons. Prof. Sourdille, of Strasbourg, and the honorary presidency of Mr. Prof. L. Binet, Dean of the Faculty of Medicine of Paris.

Order of the day: *1.* Sinusitis in infancy, reported by Mr. Prof. Terracol (Montpellier). *2.* Surgical treatment of ozena, reported by Mr. J. Ramadier and Mr. C. Eyries (Paris). *3.* Various communications.

During the Congress operatory seances will be held in the hospital services, and an exposition of instruments and oto-rhinolaryngolical specialties will take place in the grand hall of the Faculty of Medicine.

On the occasion of the Congress we have organized conferences which will take place in the morning in the office of Prof. Lemaitre in the Lariboisiere, and in the afternoon in the small amphitheater of the Faculty of Medicine.

These conferences, covering specialized subjects, be they medical or surgical of interest to the specialists, will be given by Messrs. Profs. G. Mauric, P. Mounier Kuhn, J. Despons, Mesers Drs. A. Mouchet, J. M. Le Mee, M. Ombredanne and J. Tarneaud.

During the week of Oct. 18 to 23, excursions have been arranged for the Congressmen and the people who accompany them.

The arrangements for these excursions as well as those for transportation and lodging in Paris is assigned to the Wagons-Lits Co., 40 Rue de l'Arcade.

For all information regarding administrative order or medical, please address Dr. H. Flurin, Secretary General, 19 Avenue Mac Mahon, Paris, actually in Cauteret (Haute Pyrenees), or Dr. H. Guillon, Assistant Secretary General, 6 Avenue Mac Mahon, Paris XVII.

THE AMERICAN LARYNGOLOGICAL, RHINOLOGICAL AND OTOLOGICAL SOCIETY, INC.

The 1949 Section Meetings will be held as follows:

Eastern Section—Jan. 7, 1949, Boston, Mass.

Southern Section—Jan. 10, 1949, Washington, D. C.

Middle Section—Jan. 17, 1949, Iowa City, Iowa.

Western Section—Jan. 29-30, 1949, Los Angeles, Calif.

The midwinter Council Meeting will take place in New York City on Jan. 8, 1949.

The annual meetings of the Triological Society and the Broncho-Esophagological Association will be held concurrently at the Drake in Chicago on April 18, 19 and 20, 1949. A joint meeting of these two societies will take place Tuesday morning, April 19. On the other days the Triological Society will meet in the mornings and the Bronchoscopic Society in the afternoons.

We also call your attention to these dates and places:

American Board of Otolaryngology—May 11-14, 1949, New York City.

American Laryngological Association — May 16-17, 1949, New York City.

American Otological Society—May 18-19, 1949, New York City.

In order to facilitate the coordination of national meeeings, the Bronchoscopic, the Otological, the Laryngological and the Triological Societies are considering a five-year plan of dates and places. By adoption of such a scheme we hope to reduce the traveling mileage and the amount of time away from our offices. For additional information, write to Dr. C. Stewart Nash, Secretary, 708 Medical Arts Building, Rochester 7, N. Y.

DIRECTORY OF OTOLARYNGOLOGIC SOCIETIES.

AMERICAN OTOLOGICAL SOCIETY.

President: Dr. Marvin F. Jones, 121 E. 60th St., New York 22, N. Y.
Secretary: Dr. Gordon D. Hoople, Medical Arts Bldg., Syracuse 3, N. Y.
Meeting: New York, N. Y., May 18-19, 1949.

AMERICAN LARYNGOLOGICAL ASSOCIATION.

President: Dr. Frederick T. Hill, Professional Bldg., Waterville, Me.
Secretary: Louis H. Clerf, 1530 Locust St., Philadelphia 2, Pa.
Meeting: New York, N. Y., May 16-17, 1949.

AMERICAN LARYNGOLOGICAL, RHINOLOGICAL AND OTOLOGICAL SOCIETY, INC.

President: Dr. John J. Shea, 1018 Madison Ave., Memphis, Tenn.
Secretary: Dr. C. Stewart Nash, 708 Medical Arts Building, Rochester, N. Y.
Annual Meeting: Chicago, Ill., Hotel Drake, April 18-20, 1949.

SECTION MEETINGS.

Eastern—Boston, Mass., Jan. 7, 1949.
Southern—Washington, D. C., Jan. 10, 1949.
Middle—Iowa City, Iowa, Jan. 17, 1949.
Western—Los Angeles, Calif., Jan. 29-30, 1949.

AMERICAN MEDICAL ASSOCIATION, SECTION ON LARYNGOLOGY, OTOLOGY AND RHINOLOGY.

Chairman: Dr. Fletcher D. Woodward, 104 E. Market St., Charlottesville, Va.
Secretary: Dr. James M. Robb, 641 David Whitney Bldg., Detroit, Mich.

AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY.

President: Dr. Carl H. McCaskey, 608 Title Guaranty Bldg., Indianapolis 4, Ind.
President-Elect: Dr. Conrad Berens, 35 E. 70th St., New York, N. Y.
Executive Secretary: Dr. William L. Benedict, Mayo Clinic, Rochester, Minn.
Meeting: Chicago, Ill., Palmer House, Oct. 10-15, 1948.

AMERICAN SOCIETY OF OPHTHALMOLOGIC AND OTOLARYNGOLOGIC ALLERGY

President: Dr. W. Byron Black, 530 Professional Bldg., Kansas City, Mo.

Secretary-Treasurer: Dr. Francis L. McGannon, 14900 Detroit Ave., Lakewood, Ohio.

Meeting: Chicago, Ill., Palmer House, Oct. 8-9, 1948.

AMERICAN BOARD OF OTOLARYNGOLOGY.

Meeting: New York, N. Y., May 11-14, 1949.

PAN AMERICAN ASSOCIATION OF OTO-RHINO-LARYNGOLOGY AND BRONCHO-ESOPHAGOLOGY.

President: Prof. Justo Alonso.

Secretary: Dr. Chevalier L. Jackson, 255 S. 17th St., Philadelphia, Pa.

Second Pan American Congress of Oto-Rhino-Laryngology and Broncho-Esophagology: Montevideo, January, 1950.

AMERICAN BRONCHO-ESOPHAGOLOGICAL ASSOCIATION.

President: Dr. Paul Holinger, 700 N. Michigan Ave., Chicago 11, Ill.

Secretary: Dr. Edwin N. Broyles, 1100 N. Charles St., Baltimore 1, Md.

Meeting: Chicago, Ill., April 18-20, 1949.

LOS ANGELES SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY.

President: Dr. Colby Hall.

Secretary-Treasurer: Dr. Warren A. Wilson.

Chairman of Section on Ophthalmology: Dr. John A. Bullis.

Secretary of Section on Ophthalmology: Dr. Rodman Irvine.

Chairman of Section on Otolaryngology: Dr. Leland G. Hunnicutt.

Secretary of Section on Otolaryngology: Dr. Alden H. Miller.

Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd., Los Angeles, Calif.

Time: 6 P.M., fourth Monday of each month from September to May, inclusive.

AMERICAN OTORHINOLOGIC SOCIETY FOR THE ADVANCEMENT OF PLASTIC AND RECONSTRUCTIVE SURGERY.

President: Dr. Alfred Schattner, 115 E. 61st Street, New York 21, N. Y.

Secretary: Dr. Norman N. Smith, 291 Whitney Avenue, New Haven 11, Conn.

SOUTHERN MEDICAL ASSOCIATION, SECTION ON OPHTHALMOLOGY AND OTOLARYNGOLOGY.

Chairman: Dr. Kate Savage Zerfoss, 165 Eighth Ave., North Nashville 3, Tenn.

Chairman-Elect: Dr. Calhoun McDougall, 703 Medical Arts Bldg., Atlanta 3, Ga.

Vice-Chairman: Dr. V. R. Hurst, 315 N. Center St., Longview, Tex.

Secretary: Dr. Alston Callahan, 908 S. Twentieth St., Birmingham 5, Ala.

Central Institute for the Deaf

NATIONAL RESIDENTIAL AND DAY SCHOOL FOR THE DEAF AND DEFECTIVES IN SPEECH

Approved by Advisory Council of Foremost Ear Specialists and Educators

New fire-proof buildings beautifully located opposite Forest Park. Modern Dormitories and Equipment. Best home environments. Pupils constantly in care of teachers or experienced supervisors.

ORAL SCHOOL FOR DEAF CHILDREN

C. I. D. offers all advantages of exclusively Speech Training and expert medical supervision for both Resident and Day Pupils.
Nursery School (2 years of age) through the Elementary Grades.

ACOUSTIC TRAINING FOR CHILDREN WITH RESIDUAL HEARING

Salvaging of Residual Hearing is a specialty of C. I. D. The Acoustic Method was created here. Group and individual hearing aids used for class instruction at all grade levels.

LIP-READING INSTRUCTION

Private and Class Instruction for Hard-of-Hearing Adults and Children.
Conversational Classes for advanced pupils. Speech conservation stressed.

CORRECTION OF SPEECH DEFECTS

Private and Class Instruction for children with normal hearing and delayed speech or defective speech.
Resident and Day Pupils (2 years of age through Elementary Grades).
Private Instruction for Adults.
Correction of Imperfect Phonation, Imperfect Articulation, Aphasia, Stuttering.

TEACHERS TRAINING COLLEGE

Two years of Training following a professional curriculum for applicants with adequate college qualifications. Graduates qualify for degrees of Bachelor of Science in Education or Master of Science in Education from Washington University. Graduates prepared to teach both the deaf and speech defective.

DR. MAX A. GOLDSTEIN, Founder - MISS JULIA M. CONNERY, Principal Emeritus

For further information address

DR. HELEN SCHICK LANE, Principal

818 S. KINGSHIGHWAY 10, ST. LOUIS, MO.

CONTENTS